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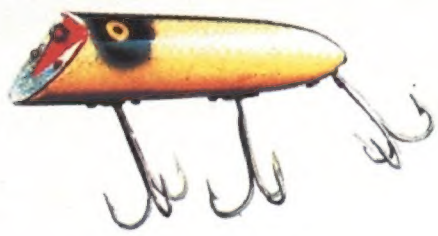

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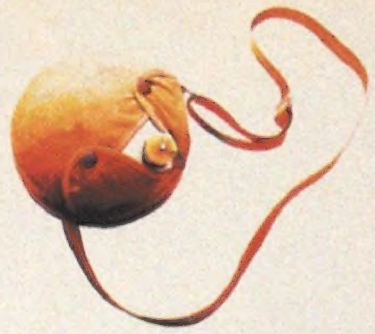

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Smithsonian

December 1999/January 2000
Volume 14 • Number 5


## FEATURES




*Cover:*
*The Red Baron Stearmans in diamond formation over Cleveland, Ohio, gave photographer Erik Hildebrandt a gem of a shot.*

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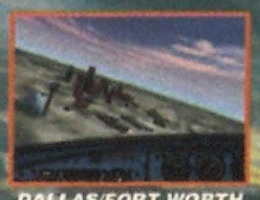
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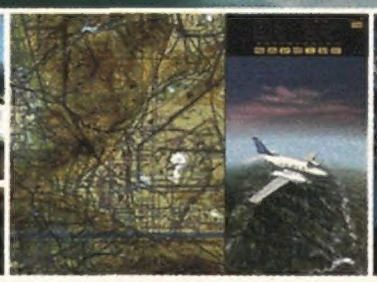


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# The Urge to Tinker

The Federal Aviation Regulations represent the rule of law in the air. They govern all forms of flight, and like most regulations, they contain an equal measure of good advice and courtesies mixed with constraints on the occasional impulse (for example, buzzing your in-laws' house). But a law or regulation can't prevent a nasty outcome—not directly anyway. All it can do is stipulate a penalty after the fact. And the same holds true for the FARs: They have never directly prevented an accident, which, by definition, entails some regulation being violated. In truth, we rely on the human instinct for survival to provide a happy ending.

We'd better maintain some perspective on the relationship between regulation and desired outcome because from time to time the urge to freshen up the FARs becomes irresistible. That urge seems strong right now, as the Federal Aviation Administration is staring at huge changes in the world of aviation.

In some nations, the important role of air traffic management—Job One for our own FAA—has been privatized. Many advocate a similar approach here and elsewhere, despite strident opposition from many who use the system. If it comes, it will be the most significant change in the agency's history.

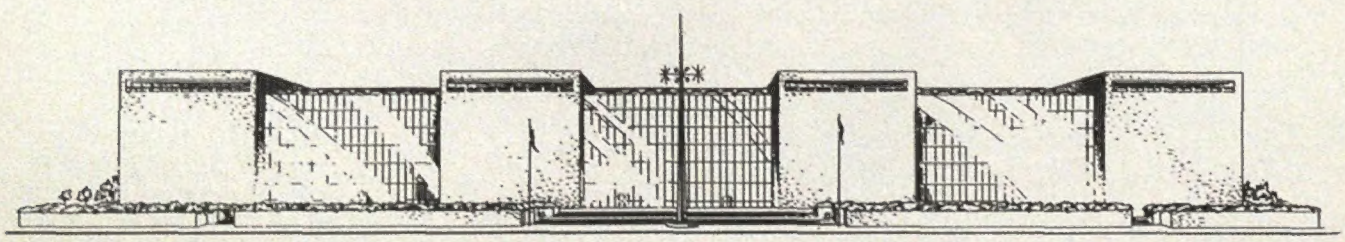
Challenges arise in the marketplace as well. "Fractional" sales of corporate aircraft, in which a company buys, say, a one-fourth share of a business jet, have enabled many companies that could not otherwise afford it to own an airplane. But charter operators complain that the stricter rules governing charter flying increase their cost. They think the charter rules (Part 135) should also apply to fractionals. Members of the National Business Aviation Association recently voted their endorsement of such a change, perhaps in part because they fear a threat to the rules that govern non-revenue-earning flights (Part 91).

Airplane operators worry about wholesale changes in rules because they fear the revision process itself, which is usually lengthy. It can also lead to unpredictable results when various interest groups see themselves in conflict with each other. Regulations can emerge that may promise improved safety but with costs and complexity users are not willing to bear.

Realizing all this, fliers are finding ways to enhance human performance based on self-help. One example can be seen in aerobatic pilot Debbie Gary's account of a formation flying school (page 26). The guiding principle is that if your own act is cleaned up, rule-makers won't be so tempted to fine-tune it.

An experienced airline pilot once told me: "Flying involves being thousands of feet in the air, going hundreds of miles an hour. Of *course* it's dangerous." But thousands of us do it every day, and it's remarkable how often everything turns out all right. That's the single most dangerous thing about flying and the reason that a pilot's experience may not be a perfect predictor of performance. While we can't be perpetual novices, success heaped upon success eventually dulls the wariness that we are blessed with when we're new at something. The history of accidents is filled with lapses by pilots deemed so capable that investigators are left shaking their heads. Still, it would be futile to look to the rules and regulations alone in the hope that we can perfect human nature.

*—George C. Larson*





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# LETTERS

## Spin Control

"The One-Pound Problem" (Oct./Nov. 1999) gave a fine and mostly accurate version of the saga of the Miniature Mars Ascent Vehicle (Mini-MAV) and its evolution from the secret NOTSNIK response to Sputnik developed 40 years earlier by my father and his team at the Naval Ordnance Test Station. However, it contains an error that leads to a completely erroneous conclusion.

The article states that the current MAV does not use "spinning upper stages stabilized NOTSNIK-style.... And so, hardly a year after it was first proposed, the last vestige of Mini-MAV simply disappeared." This statement is not correct. The essence of NOTSNIK was to use one rocket stage to loft a spin-stabilized, unguided upper stage assembly above the atmosphere. This spinning upper stage can achieve orbit without the extra fuel that would be required to accelerate a guidance and control system to orbital velocity. This achieves huge mass and cost savings for orbiting very small payloads. It is exactly this concept that is still the basis of the current MAV design, and is the reason that it was possible to discard the large, complex, and expensive liquid-fuel MAV.

To be sure, NOTSNIK had several features not adopted for the current MAV, notably the corkscrew fins to achieve the needed spin and horizontal pointing near the top of the atmosphere, and the backward, delayed final stage to lift the low point of the orbit up from that atmospheric insertion point for longer orbital life. Instead, the current MAV design has a guidance and control system on its first stage, allowing accurate pointing well above the atmosphere, where the spinning assembly can directly enter a long-life orbit. However, these nuances are not part of the basic concept, which continues to be employed in the MAV design.


It is a great tribute to that team of men and women who labored tirelessly 40 years ago and were, under the veil of cold-war secrecy, denied recognition that their idea, in the words of JPL director Edward Stone at a recent award ceremony, "enabled Mars Sample Return."

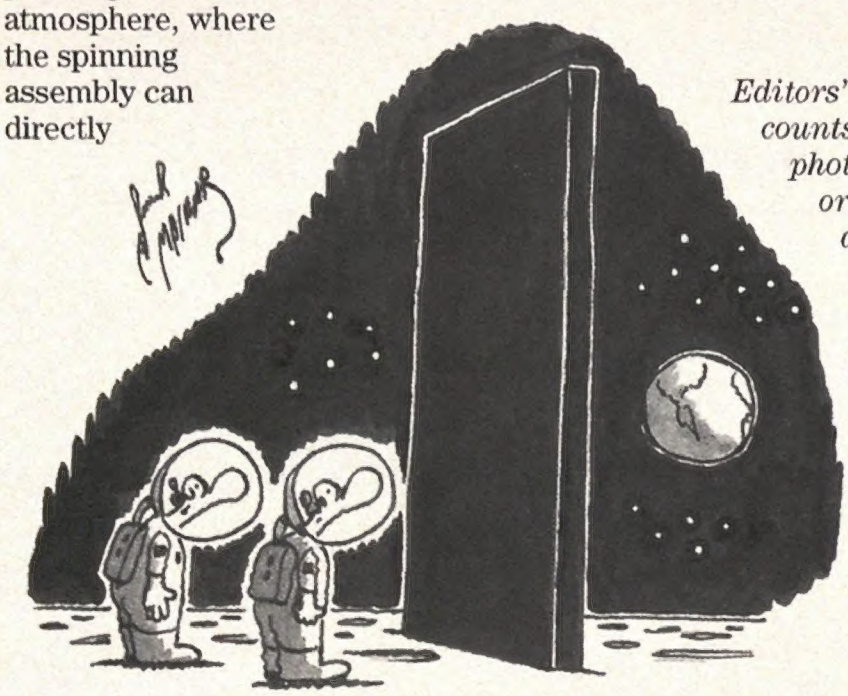
—Brian Wilcox
La Canada, California

## Hold Upside Down in Front of Mirror...

Having been conditioned by conventional maps, our orientation assumptions typically place north at the top when it's not otherwise indicated. So the shuttle image of the Himalayas ("Ninety Minutes," Oct./Nov. 1999) provided a challenge for someone trying to make sense of the deep mountain shadows. In this one, north is at the left, right? In the image of Washington, D.C. ("Art of the Chart," Oct./Nov. 1999), north is at the bottom, right?

—Peter Wiinikka
via e-mail

*Editors' reply: Right on both counts. However, high-altitude photos aren't necessarily oriented to cardinal directions.*



*"I'm not sure, but I think it's Y2K-related."*

## Geography 101

In "Art of the Chart" (Oct./Nov. 1999), the photograph that you say is of Boston actually shows Everett, Chelsea, and part of Winthrop, Massachusetts. The photograph of "Washington, D.C." is mostly of Virginia. And the photograph of

# Details.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"Rockland, Maine" shows some location, but not Rockland.

—Tom Hiniker
Lexington, Massachusetts

*Editors' reply: Several readers were distressed by our apparent lack of geographic knowledge. While we admit the labels could have been a little more precise, they were merely meant to provide general regional orientation.*

## Mach 3 Bomb Drops

A reader asked about the bomb bays on the XB-70 (Letters, Oct./Nov. 1999). As a wind tunnel engineer for North American Aviation in 1959, I conducted what were then highly classified store (bomb) drop tests from a B-70 wind tunnel model, at both transonic and supersonic speeds.

NAA had several constraints put upon the bomb bay design. The Air Force had specified that the B-70 stores, attach method, and handling equipment be compatible with the B-52. We used a three percent scale model, and the stores were scaled aerodynamically and dynamically—in accordance with the Air Force's requirements—and weighted to simulate full-scale movements of inertia and center-of-gravity locations. Drop-testing using dynamic simulation techniques in wind tunnels was certainly not new in 1959. That was the established method of predicting store separation characteristics. However, developing good separations at Mach 3.0, from a very large vehicle generating complex and not well-understood flow and shock patterns, was new. We tested store drops through a Mach range of 0.7 to 3.0. The separations were recorded on a multi-exposure, rotating-disc shutter camera and by high-speed movie cameras. The procedure was repeated over 200 times to test various store configurations in the forward and aft bays. Upon completion of the testing, we carefully collected and weighed all the bits and pieces of the used stores to be sure we had every morsel of the "classified scrap" accounted for.

Another bit of B-70 lore involves a wind tunnel test in which runs were made with a simulated missile piggybacked on the B-70. This missile was a dead ringer for the X-15. Another "What if?"

—A. Leroy Clark
Santa Fe, New Mexico

## Spirits of the Past

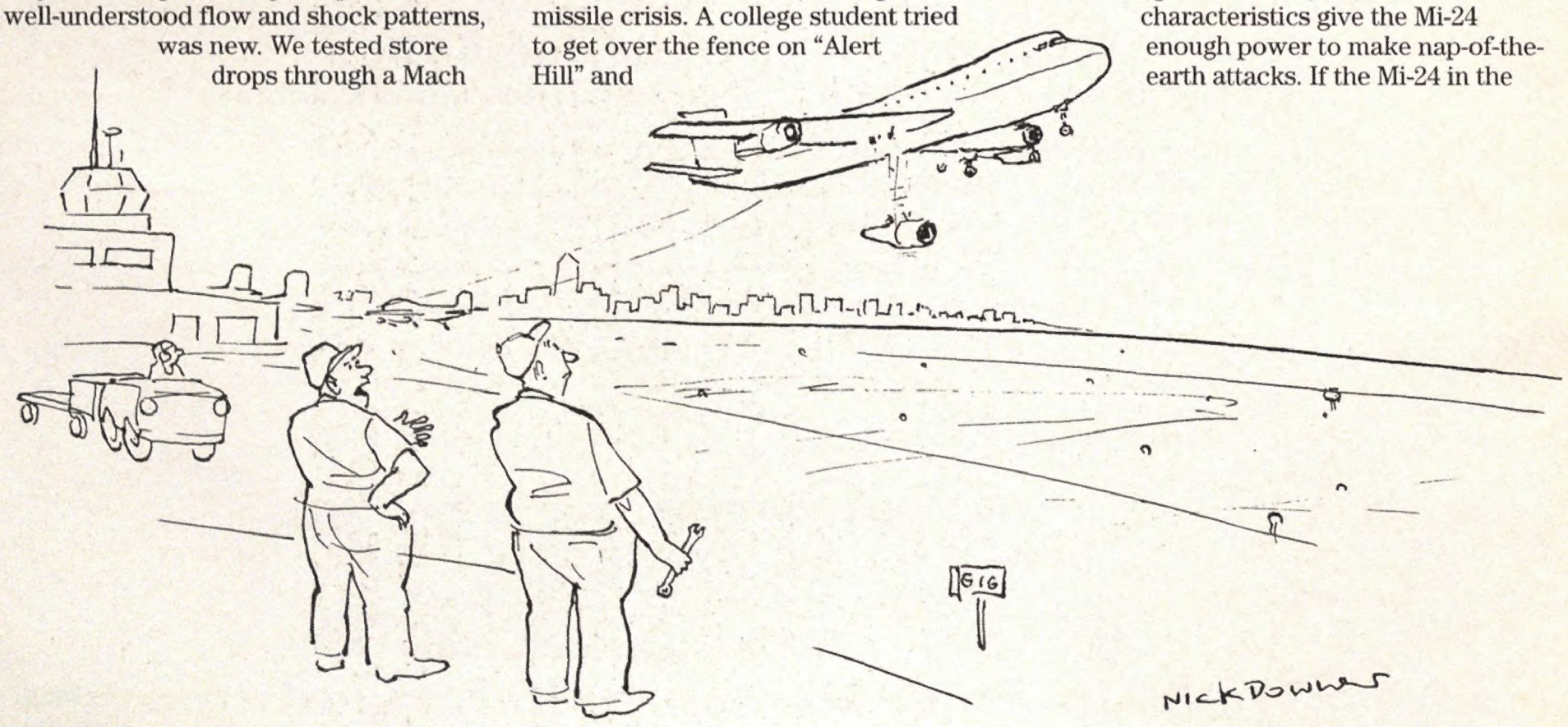
"The Spirit of Knob Noster" (Oct./Nov. 1999) brought back memories of my time at Whiteman Air Force Base. In the early 1960s, I was assigned to the 340th Field Maintenance Squadron. In the two years I was there, I saw the Air Force undergo considerable change and growth. By mid-1963, the KC-97 tankers, B-47Es, two T-33s, two C-47s, one C-123, and a mixed bag of smaller aircraft were on their way to other bases or Arizona. As the aircraft left, the Minuteman "gun barrels" were being constructed and armed.

For the most part, we were accepted by the nearby communities and got along well with them. The only time we experienced trouble with the residents was in October of 1962, during the Cuban missile crisis. A college student tried to get over the fence on "Alert Hill" and took a bullet in his leg. It didn't make the news, but it did create a stir. In spite of that, Whiteman was a good duty place, and with all of the improvements made for the B-2 buildup, it can only be better.

—Frank Bruni
Lynnwood, Washington

## Grasping the Hind

I have profound respect for the pilots, scientists, and technicians who mastered the many difficulties of the Soviet-built Mi-24 Hind helicopter gunship ("Mean Machine," Apr./May 1998). I worked as a lead flight test engineer at the Russian Mil Helicopter Design Bureau for more than 20 years and was involved in flight tests and final designs of several modifications of Mi-24 Hinds and the first three prototypes of the Mi-28 Havoc. Based on my years of research and testing of the Mi-24, I think that the helicopter's battle efficiency and survivability are higher than William Smallwood indicated. He writes: "It doesn't hover like any respectable helicopter. It [hovering] is not permitted more than a cumulative six minutes over the life of the engines," and the "Mi-24 cannot fly nap-of-the-earth attacks." These statements are not correct. All Mi-24s produced since 1980 have a hovering ceiling out of ground effect at no less than 2,000 meters (6,560 feet) and can use takeoff power for as long as six minutes at a time, with the cumulative time being no more than a quarter of the total service life of the engine. Certainly these characteristics give the Mi-24 enough power to make nap-of-the-earth attacks. If the Mi-24 in the




*"It's righty-tighty, lefty-loosey!"*

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*"Well, it's another busy day on the old 416. It's thorax to thorax as far as the eye can see."*

article can't hover and fly nap-of-the-earth attacks, either its engines can't reach takeoff power or its main rotor adjustment is incorrect.

—Yuri Krasnovskiy
Kirkland, Washington

## Mega-mistake

In "Rehab for Rockets" (Oct./Nov. 1999), Preston Lerner states that the Minuteman II carried a 12-megaton nuclear warhead. *U.S. Nuclear Weapons* by Chuck Hansen states that the largest warhead the Minuteman II carried was the W-56, which had a 1.2-megaton rating. Hansen's book lists the nine-megaton W-53, which was carried on a Titan II, as the largest warhead ever deployed on a U.S. missile.

—W.H. Sparboe
Mount Carroll, Illinois

## Cameo Appearance

In the opening photograph in "Working for the Wright Brothers" (Oct./Nov. 1999), the gentleman seated at right is Cal Rodgers, the Wright-trained pilot who was the first to fly coast to coast, piloting his Wright Flyer *Vin Fiz* in 1911. Rodgers' aircraft is now in the collection of the National Air and Space Museum.

—John Mullen
Berne, New York

## Game Spotting in Africa

The photo in the lower left of page 82 of "The Legends Club" (Oct./Nov. 1999) is indeed a Sikorsky S-39, but the name is incorrect. The right name is *The Spirit of Africa*. The aircraft that bore the name *Osa's Ark* was a Sikorsky S-38 twin-engine aircraft. The plane pictured has giraffe spots and is thus the S-39; the S-38 had zebra stripes.

—Wm. W. Ford Jr.
Atlanta, Georgia

*Editors' reply: Good eye. We all know that a zebra can't change its spots. No, wait...*

What I would have given to have been a fly on the wall at the Aero Club of yesteryear! Sometimes, one is compelled to ruefully admit, they indeed were the good old days. I roamed that part of Kikuyu-land and also serviced the radio at Mweiga when I was in the Kenya police force. One time, a Kenyan police pilot named "Punch" Bearcroft flew me to Kitui in a Cessna 180 tail-dragger. Bearcroft had lost his right hand at the wrist, so he flew the plane with his stump attached to the yoke by a band.

I later transferred to the Directorate of Civil Aviation, at Wilson Airport. The outer marker of the instrument landing system of the east-west runway is located in the middle of Nairobi National Game Park. One night, the duty engineer was sent to the hut at the outer marker to make repairs. The hut had a fence with a gate. The engineer arrived at the place, and guess what he saw in the glare of the Land Rover's headlights? *Bwana Simba*—a lion—lying beside the gate. What do *you* think the engineer did?

So I'll say, *Asante sana, Bwana!*
[Editors' note: In Swahili, "Thank you very much, sir!" Our reply: *Karibu, Bwana*—"You're welcome, sir."]

—Erich Rustom Bajina
Mississauga, Ontario, Canada

## Red-Faced Rollout

While in high school I built several models of the "Mr. Mulligan," including a six-foot-wingspan model powered by an early gas engine ("Howard's End," Soundings, Oct./Nov. 1999). None flew well, but they were beautiful. At Douglas Aircraft in the late 1940s, where I worked on maintenance manuals and the DC-7 pilot's handbook, I was privileged to fly several times with Ben O. Howard, then chief pilot.

At the press and airline introduction of the DC-7 at Fox Field in Santa Monica, Howard flew several high-speed passes (300 mph), then initiated a short-field landing. With the four R-3350 engines in full reverse, he stopped only a few hundred feet beyond the center of the throng witnessing a good flight demo. Howard wasn't about to quit there. Continuing in full reverse pitch, he backed the DC-7 to the middle of the crowd. All four engines were smoking hot and when the props stopped, the black smoke and fire was visible! The standby fire wagons rolled out—to the consternation of the Douglas executives.

—William C. Strang
Perris, California

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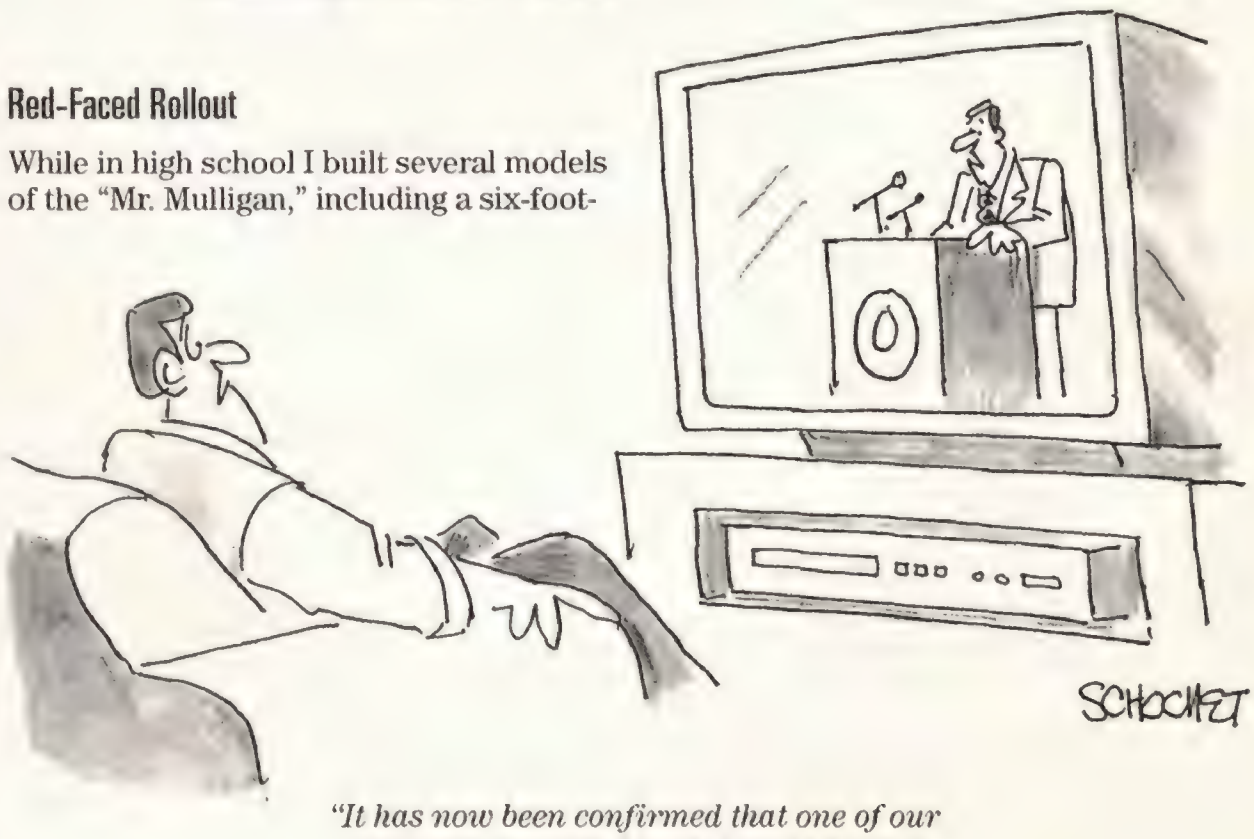


*"It has now been confirmed that one of our anti-anti missiles has shot itself down."*

AIR & SPACE CONTEST

# UNIDENTIFIED FLYING OBJECT CONTEST

The newsstand contest is over but we still have winners to announce and credit to give for the photographs used throughout the contest. We thank everyone for their participation. Here's a recap.

### December/January 1999 Contest
Correct Answer: Leduc 022
Winner: Mich Yoshii of California
*photo courtesy of National Air and Space Museum*

### February/March 1999 Contest
Correct Answer: Northrop N-23 Pioneer
Winner: Stan Seashore of Arizona
*photo courtesy of National Air and Space Museum*

### April/May 1999 Contest
Correct Answer: Transavia PL-12 Airtruk
Winner: Cleon R. Gleason of Texas
*photo courtesy of Howard Levy*

### June/July 1999 Contest
Correct Answer: Beechcraft Twin Quad
Winner: Thomas Sebik of Colorado
*photo courtesy of Peter Bowers*

### August/September 1999 Contest
Correct Answer: Schweizer RU-38A
Winner: Mark A. Mailloux of Michigan
*photo courtesy of Schweizer*

### October/November 1999 Contest
The drawing is pending.
Watch this space for the correct answer and winner's name.

"European Air War's outstanding gameplay and wealth of features make it the current leader of the WWII simulation crop" *-PC Gamer, 89%, Editor's Choice Award*

"This World War II simulation captured the feeling of being in a living, unpredictable combat environment better than any other sim released this past year" *-Computer Gaming World, 4 stars*

"European Air War succeeds at providing the experience that makes arm-chair fighter pilots believe they're truly leaving their mundane surroundings behind" *-Gamespot*

# RACKING UP

"No previous sim covers so many different weapons and so many tasks in detail... it's all here and it's all beautifully executed" *-PC Gamer, 95%, Editor's Choice Award*

"Falcon 4.0 is the deepest, most complex air combat sim yet... The campaign also creates the greatest sense of playing a small but important part of a huge battle" *-PC Gamer*


"Thoughtful gameplay design and the effort to bring players a sense of the true fighter pilot's experience can be felt throughout the game" *-Computer Games Strategy Plus*


"European Air War combined huge dog fights, a great campaign system and realistic physics to make a game that was very hard to put down"
*-IGN PC.com, Sim of the Year*

"The care and attention to detail that went into every aspect of European Air War, from the hefty manual to the bomber nose art, represents a serious achievement"
*-CNET GameCenter*

# THE KILLS!

"Bottom line: this sets the new standard in flight sims"
*-Washington Post*

"Falcon 4.0 is an incredibly detailed simulation that in many ways exceeds training systems in military use."
*-Computer Gaming World*

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# The News From Lake Keuka

There were Fords with alphabet letters for names, a brass band tooting ragtime standards at the end of the dock, men wearing straw boaters, and aviator Karl Erickson gamely posing in backward cloth cap, tie, vest, jodhpurs, and knee-high argyles. At exactly 10 a.m. last August 7, the event that everyone was waiting for began. Erickson donned goggles (as well as a decidedly non-period yellow nylon life jacket) and chuttered down Lake Keuka in a 1913 Curtiss Model E flying boat, attempting to become the first person to publicly fly such a machine on this side of the half-century mark.

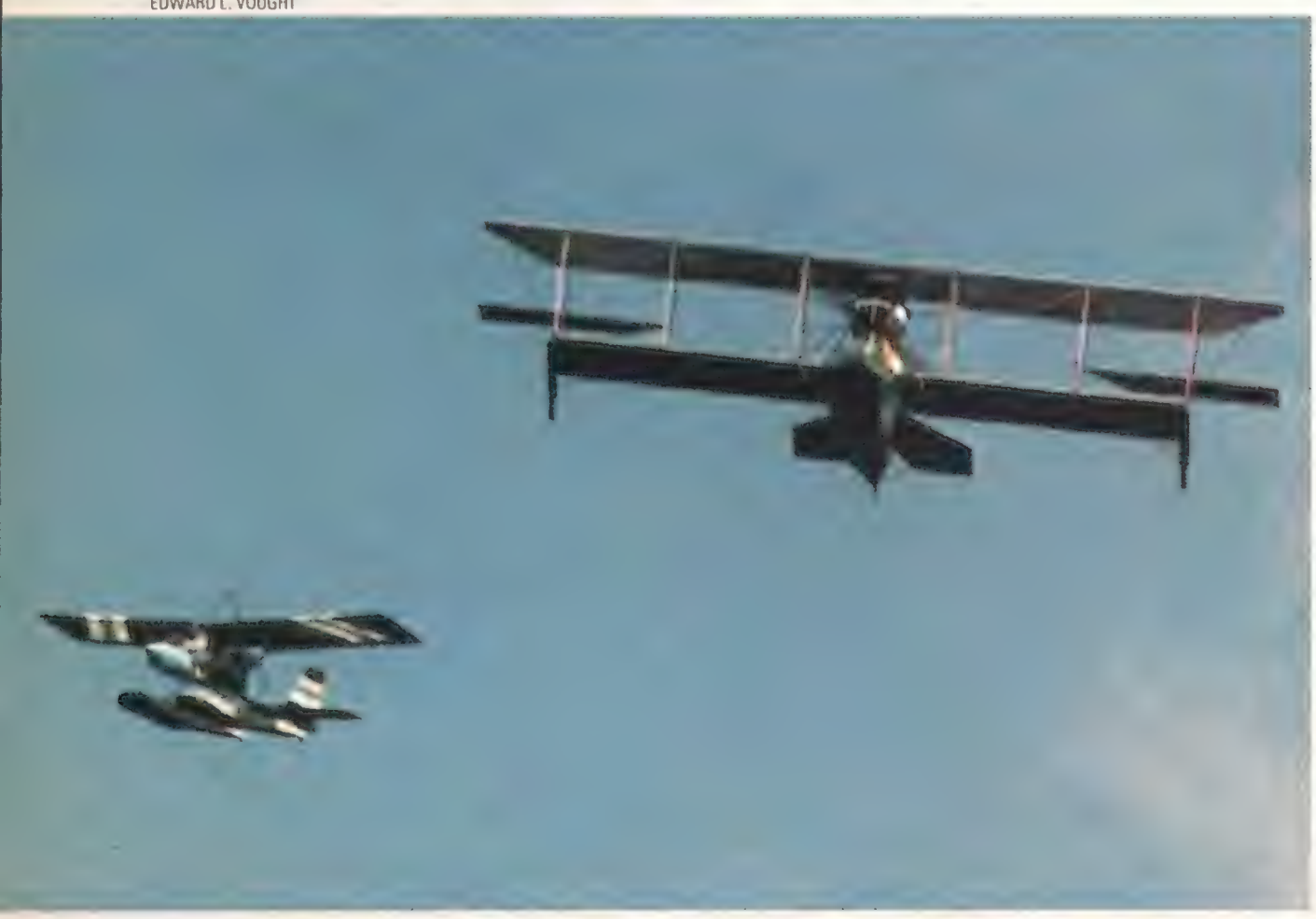
Not surprisingly, this "aerial yacht," as Glenn Curtiss called such vehicles in his promotional literature, is a reproduction, built in the mid-1990s by two dozen volunteers at the Curtiss Museum, which is just outside the pioneer aviator's hometown of Hammondsport, in Upstate New York. None of Curtiss' earliest machines survive today, in part because he had his eye on the future profits of his business instead of its past. Then again, there was little to preserve. "There was not much to them—they were basically wood and fabric," says Kirk House, the museum's director. "And pieces of old ones got reused in newer airplanes. There was not much to save except maybe the engine." All the museum's exhibits of early Curtiss craft—the 1908 *June Bug* (winner of the *Scientific American* trophy), the 1909 *Silver Dart*, and now the Model E—had to be built from scratch. But before they're locked away inside, the museum puts each through a sort of public trial by flier.

An accurate reproduction (the 1913 aircraft was built for one Jack Vilas; the National Air and Space Museum loaned what's left, the hull, as a display), the Model E has the archaic Curtiss control system: There are no rudder pedals, and a shoulder harness, not a steering wheel, turns and banks the aircraft. Too, it's a seaplane. You don't need many pinkies to count the pilots qualified to fly such an exotic beast: One. Karl Erickson. "If you think 'car,' it's no problem," Erickson modestly explained. Of course, along with a seaplane rating, he has 14 years' experience flying the Old Rhinebeck Aerodrome's Curtiss Model B pusher.

But before Erickson could even taxi out, there was the requisite christening ceremony, with guest of honor Hazel Vilas, the 80-year-old widow of Jack Vilas. "[The Model E] was in the Smithsonian when I met him," Mrs. Vilas said later. "He had it built and he helped build it. He was with Glenn to insist—rather, suggest—it be built the way he wanted it to." House added, "Jack was a well-to-do fellow of whom one contemporary newspaper said he was 'struggling along on $30,000 a year.' He had a good time. In his later years he said, 'I have done everything I wanted to do in life except hit a hole in one.' "

The reproduction's debut flight, con-

EDWARD L. VOUGHT



COURTESY GLENN CURTISS MUSEUM

*Glenn Curtiss custom-built a 1913 Model E-8 "aerial yacht" with plenty of input from its purchaser, Jack Vilas (above), who in 1948 gave what was left—the hull—to the Smithsonian. Today a meticulous and airworthy reproduction (left, tailed by a curious ultralight on floats) resides at the Glenn Curtiss Museum in Upstate New York.*

sisting of a couple of low orbits around Lake Keuka's calm, bright skies, followed by what seemed like the smoothest water landing in the history of aerial yachting, lasted 13 minutes. After coasting gently to shore, Erickson shook hands and grinned for spectators' cameras, while volunteers carefully lashed the Model E to shore. Then they waded up to their knees to sponge water from its green hull and translucent wings, and no doubt surreptitiously survey for scratches. After one more flight in the calm winds of late afternoon, its flying days are pretty much over, and that is probably fine with most of its builders.

"It's too valuable—it's priceless," explained volunteer Gil Aschettini. "We've put five to six thousand hours in it," added Al Clarke, another volunteer. "If we had to pay people to do that, what would the going rate be—20, 25 dollars an hour? Woodworking specialists, master machinists: These are not minimum-wage folks."

*—Phil Scott*

## Keeping the Shiny Side Up

Next spring, at Hurlburt Field in Panama City, Florida, the U.S. Air Force will outfit two H-53 helicopters with a new gizmo designed to keep pilots safe from spatial disorientation: a vest with a matrix of vibrators sewn into the lining. Under development at what might be considered the Disneyland of spatial disorientation, the Naval Aerospace Medical Research Laboratory in Pensacola, the Tactile Situational Awareness System vest could someday be a $15,000 option in private aircraft.

A room that spins at up to 33 rpm and a gurney that rotates like a barbecue spit are just a couple of the torturous devices Navy Captain Angus Rupert uses to disorient his subjects before he asks them to don his olive drab invention and grab the stick of a virtual helicopter. "Keep it straight and level," he commands as a graphic display turns the horizon upside down and the vest comes alive with buzzers.

Sight is the primary sense that tells us which way is down. When vision is lost—in a darkened room, for example—we get a little help from our inner ears as well as muscles, joints, and nerves in the skin. They provide continuous orientation information to the central nervous system so we can sit upright and walk erect. "When you get in an aircraft, [these senses] give you false information in any condition other than straight and level flight," says Rupert.

The TSAS takes advantage of "a targeting reflex you developed before you left the womb," says Rupert. "When someone taps you on the shoulder, you look in their direction."

Linked to the aircraft instrument panel with an electronic controller and pneumatic tubes, the vest translates pitch, roll, and attitude information. When one or more of the parameters change, a pneumatic buzzer called a tactile stimulator, or tactor, buzzes a corresponding spot on the wearer's torso. Three vertical rows of tactors run down the front of the vest from shoulder to waist. Bank to the right, and the bottom right tactor buzzes. The steeper the bank, the higher on the chest the tactor buzzes. Pitch the nose down, and the tactor on the lower abdomen buzzes. When the aircraft is straight and level, the buzzing stops.

"No training required," says Rupert. I've never flown an airplane, but I got the hang of it in the simulator in five minutes.

At the Naval Air Test Center in Patuxent River, Maryland, Jim Baker, a retired naval aviator with 7,000 hours in the air, strapped on a vision-restricting hood, climbed into the back seat of a T-34C turboprop that had its instruments removed, and flew loops, barrel rolls, ascending and descending turns, and ground-controlled runway approaches. "They attempted to put me in unusual attitudes, but they couldn't do it because the tactors made me aware of what was going on," he reports. "If I would roll too far right or too far left I would get a tactor. I was maintaining the aircraft where it needed to be within one degree." A subsequent test at the U.S. Army Aeromedical Research Laboratory in Alabama showed that disoriented and blindfolded helicopter pilots could recover from unusual attitudes less than 15 seconds after their vests were turned on.

The getup weighs a few pounds, but pilots don't seem to mind because, thanks to the pneumatics, the vest is air-conditioned. But it could be several years before the vests are used operationally in military aircraft—and even longer before the commercial sector spins it off for general aviation use.

*—Beth Dickey*

UPDATE

### Departure

Irven H. Culver, the Lockheed engineer who came up with the nickname "Skunk Works" ("How the Skunk Works Works," Apr./May 1994), died last August in a Bakersfield, California hospital at age 88. In his nearly 30 years at Lockheed, Culver worked on the XP-80, the Constellation, the F-104, and the X-7 reentry test vehicle, and designed a rigid rotor system for Lockheed helicopters that garnered an award from the American Helicopter Society.

UPDATE

### Coming to a TV Near You

Curt Newport and an expedition team plucked the *Liberty Bell 7* Mercury capsule from the ocean floor last July after a previous expedition resulted in the loss of a Magellan Remote Operated Vehicle ("Lost, Found, and Foundered," Soundings, Aug./Sept. 1999). The ROV remains a loss. Funded by the Discovery Channel, the recovery expedition was filmed, and the footage will air in a documentary, "In Search of *Liberty Bell*," at 9 p.m. EST on December 12.

## Flagships

The two Air Force C-141 Starlifters were on their way to a rendezvous with a KC-135 tanker over central Oregon one day in the summer of 1998 when they heard a pilot calling Seattle Center to report that the engine of her Cessna Turbo 210 had failed. She said she was going down. The voice was calm, precise. Center was silent, unaware of the Cessna pilot's dire circumstances because the light aircraft's transmissions were by then blocked by the foothills in the remote, forested area.

The Air Force pilots, reservists with the 446th Airlift Wing at McChord Air Force Base in Washington, began relaying messages between the Cessna pilot and air traffic control. The woman gave her altitude and position; she knew she was too low to deadstick to any airport.

Then she said, "I see a road—too many trees!" There were no more transmissions.

After alerting ATC, the transport pilots banked their huge craft and began a dash toward the Cessna's last reported position, about 100 miles away—12 minutes by Starlifter. What they found there was a sea of green pines stretching forever. The two airplanes split, the crew in one searching north and the other south.

Presently, flight engineer Master Sargeant Todd "Buck" Murray tapped copilot Lieutenant Colonel Pete Buehn on the shoulder and pointed out the right side window at what appeared to be a white log. Command pilot Captain Paul Parrinelli closed in for a better look. Bingo! A 210 buried among tall pines. There was no sign of fire. Or life.

The two transports began orbiting the Cessna, with the high one transmitting news of its find. Help would be on its way, but the crews were frustrated. Directly below was a pilot who, if alive, was probably hurt, possibly dying, and they could do nothing except watch.

Then off in the distance they spotted a

rooster tail of dust. They zoomed toward it to investigate, hoping it was a rescue team. But it was only a pickup truck galloping along one of the several dirt and gravel logging roads cut through the forest. As the truck drew closer, now tooling along a road that passed near the downed airplane, Parrinelli and Buehn had a quick strategy session.

Rod Holman, an alfalfa farmer, was taking a shortcut home through the Fremont National Forest when he spotted the C-141s criss-crossing over the road up ahead. They were low. Way low. He slowed his Ford F250 so his wife and boys could take in the improbable airshow. Just then one of the gray behemoths roared overhead, so low the truck shook in the wake that then churned the tips of the surrounding pines. The airplane pitched up and banked hard to the right.

"Holy smoke," uttered Holman. And then he spotted it. Over to the right, about 150 feet in the forest, was an airplane jammed in among the trees. Holman stopped the truck, got out, and approached. At first he thought the thing was abandoned, but as he got closer he saw fresh blood all over the cockpit.

He looked inside, dreading what he would find. There was Patty Burrell, shaken but very much alive. In fact, apart from a head gash and some disorientation, the 69-year-old instrument instructor was in remarkably good condition.

Just then the two Lockheeds roared by again, and in that instant Holman understood the purpose of the pilots' wild performance: They'd been using their giant aircraft as distress flags.

Burrell fully recovered from her injuries and replaced her wrecked 210 with a Cessna 182. Meanwhile, she and the Holman family were adopted as honorary members of the 446th. They celebrated their good fortune over an Air Force barbecue.

*—William Garvey*

UPDATE

### The Party's Over

After 40 years of tongue-in-cheek debunking of the Wright brothers' accomplishments ("Never Say Fly," Flights & Fancy, Apr./May 1990), the Man Will Never Fly Memorial Society (motto: "Birds Fly—Men Drink") is calling it quits. In a recent letter to all 6,000 card-holding MWNFMS members, chief debunker Ed North wrote, "We wanted to put some life into the December 17th Celebration as put on by the Kill Devil Hills Memorial Society. Do you think we helped? For forty years grown-ups have been asking what our group is all about. During this time I have never known myself, so I just say 'fun.' It's been great fun. May you have blue skies and a tail wind forever."

## Hey Mister, What's That Piece of Concrete in Your Airplane?

Just before last summer's Paris Air Show, Lockheed Martin decided to set some world records with its C-130J Hercules. This latest version of the timeless military airlifter (see "The Big 10," Feb./Mar. 1996) has four 4,591-shaft-horsepower engines and six-blade propellers, which provide the airplane with a considerable performance boost over previous C-130s. Attempting to set records just before the world's largest aerospace trade show was one way to generate some buzz.

The company arranged for an official observer from the National Aeronautic Association, which would certify the record attempt to the Fédération Aéronautique Internationale, the organization that sanctions world records. Last April 20, pilots Arlen Rens and Lyle Schaefer took off, broke 10 existing speed records, and set four new ones while hauling a payload of 44,604 pounds, about twice the load carried by the previous record holder, a Soviet Antonov An-12. Later that afternoon, the pilots set two altitude records and broke five of the existing marks.

Official press releases described the contents of the C-130J's cargo hold as a "militarily usable cargo." I asked Lockheed spokesperson Jeff Rhodes why the payload was described in such a vague way. What was the nature of the cargo, anyway?

The payloads, he wrote, were large concrete pallets that were weighed precisely. "The point was to carry a load—20,000 kilograms on the Class C-1.N records (for situations where you actually had a landing strip) and 10,000 kilograms in the short-takeoff-and-landing category (for the times you have to go into Khe Sahn)—that was representative of the weight of a typical load useful in a combat situation—guns, ammunition, fuel, Meals Ready to Eat—whatever is necessary to support the force on the ground. In other words, it represented a load that would be of real value to the ground troops." Other record attempts might have used a C-130 to deliver a single box of ammunition just to set a record.

The Lockheed crew came up with a


ROGER SCRUGGS FILMS

A 265-foot mobile service tower and 175-foot umbilical tower were toppled last October at the historic Space Launch Complex 41 at Florida's Cape Canaveral Air Station. The implosion of the old towers clears the pad for Lockheed Martin's new Atlas 5 heavy-lift booster, which will be ready for service in 2001. From 1965 to 1999, SLC 41 was the departure point for 27 hulking Titan rockets carrying payloads that included NASA's Viking Mars landers and Voyager interplanetary probes as well as several top-secret Department of Defense satellites. It took demolition teams two days to place 200 pounds of linear charges—the same explosives used for rocket flight termination systems—at strategic points on the towers, and less than 60 seconds to reduce the structures to seven million pounds of twisted steel. Lockheed Martin is salvaging some of the metal for souvenirs; the rest will be recycled.

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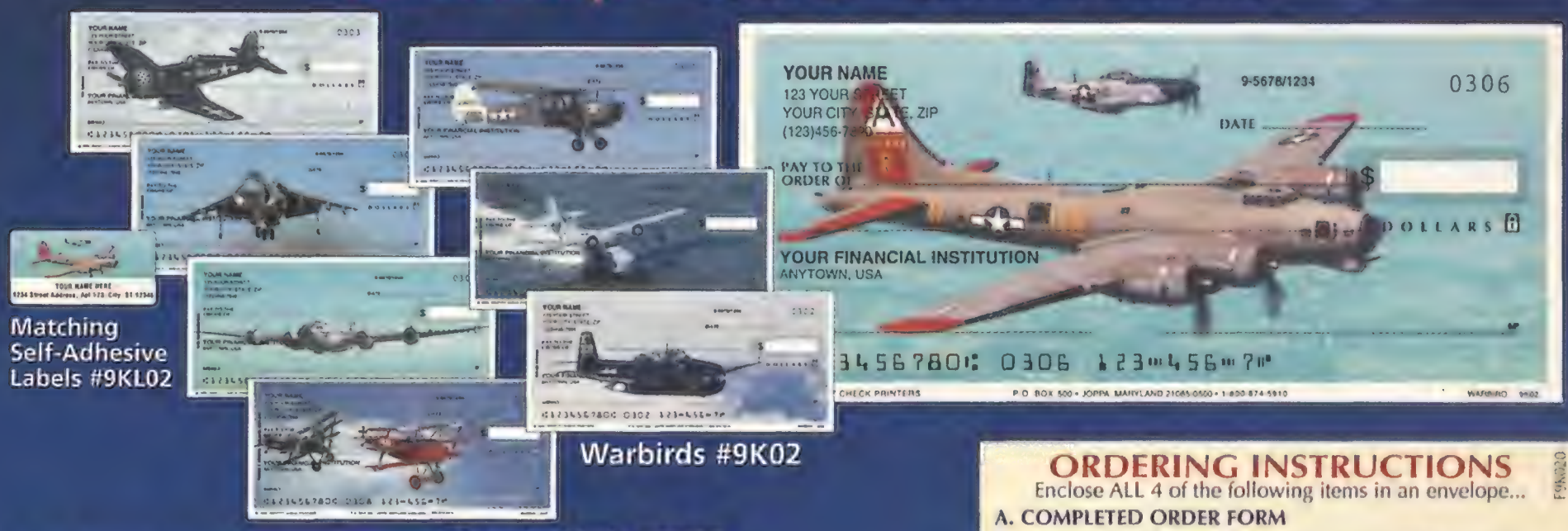


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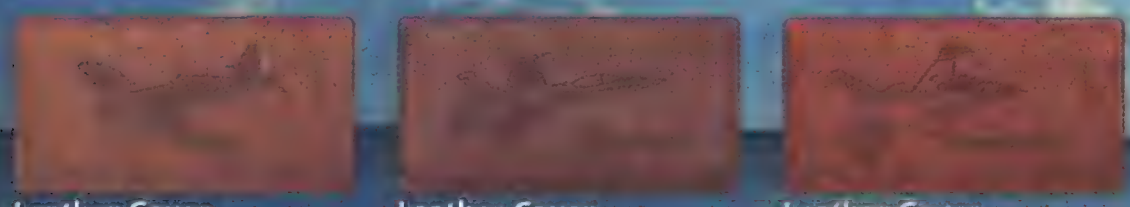

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special term for the concrete ballast: "We called 'em pet rocks," said Rhodes.

*—George C. Larson*

## Night Moves

Around midnight last September 18, an unusual move took place. The only unscathed pre-World War II European airline terminal surviving was moved just over a mile westward across the runways of Denmark's busy Copenhagen Airport, a move dictated by the airport's steady eastward expansion. In a party atmosphere, VIPs and reporters celebrated permanence in an age of rapid change as well as the setting of a new world record: the largest building in its class (2,800 tons, 360 by 85 feet) moved over the greatest distance (7,200 feet).

Opened in 1925, Copenhagen Airport is the main transit hub for the Nordic and Baltic regions. For its time, the 1939 landmark terminal, designed by Danish architect Vilhelm Lauritzen, was an innovative example of Nordic Functionalist architecture. Its corrugated concrete roof not only crowned the large transparent reception hall but also kept noise at an acceptable level. One year after the terminal was opened and after 70,000 passengers had passed through it, Nazi Germany occupied neutral Denmark and turned the building into a military headquarters. Cloaked in layers of camouflage netting, it looked like the only hill on the island. After the war, with air traffic booming, several barrack-like extensions prolonged its useful life but also masked it. A new terminal replaced and dwarfed it in 1960 and relegated its use to domestic flights and then to office and storage space. In the early 1990s, it was used as a transit hall for Americans heading for charter cruises.

To prepare for the move, workers stripped the landmark of its extensions. Walls and windows on the ground floor were removed to make room for heavy moving equipment, and steel girders were placed on each side of the building's 80 free-standing columns to stiffen the three-story structure. Its restaurant was cut away, as it would be moved separately. To avoid conflicts with air traffic, the airport scheduled the move for early Sunday morning, when no flights would be arriving or departing.

Liftoff onto hydraulically controlled trailers was the moment of truth. "Once it's on the trailers," said Wessel Helmens, head of engineering for equipment subcontractor Van Seumeren Holland BV, "you generally can't go wrong anymore." Even so, project leader Kim Hansen and crew, working for contractor Monberg and Thorsen, watched the building, pausing several times to readjust the forces on the building. It had arched noticeably, a foot higher in the middle than at its ends. "We were a little surprised—and very pleased—that the building could withstand so much deviation," Hansen said.

On Sunday the old terminal was lowered onto its new foundation. Once restored, it will house administrative workers. In its new location, surrounded by smaller buildings, it will resume its former stature.

*—Jerome Rosen*

UPDATE

### Because It's Still There

A British organization is seeking to recreate the first flight over Mount Everest, which the Houston Expedition made in 1933 in a Westland Wallace biplane (Sightings, Feb./Mar. 1999). Wings Over Everest plans to build a replica of the biplane with an updated cockpit and a 650-horsepower radial engine instead of the original 525-hp Bristol Pegasus.


VILHELM LAURITZEN AS (2)

# "I dreamed of being a fighter pilot"

*Colonel Joseph S. Benham, USAF (ret.)*

As a young boy growing up in Illinois, I dreamed of being a fighter pilot. That dream became a reality over 50 years ago when I graduated from the Air Corps cadet class 43K. I was assigned to the Panama-based 51st Fighter Squadron, patrolling the Pacific approaches to the Canal. I will never forget serving my country as a member of the Army Air Corps.

We can help future generations understand aviation's role in America's history. The Smithsonian Institution's National Air and Space Museum, through its unparalleled collection, brings the amazing story of flight to life.

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# The Mystery of the MiG

Russ Lee is an aeronautics curator for the National Air and Space Museum, and it's his job to piece together the occasional historical puzzle that some of the Museum's aircraft present. Lee has successfully uncovered the histories of the Museum's North American B-25 Mitchell bomber and its collection of Horten gliders. His latest case, however, a Mikoyan-Gurevich MiG-15bis, has him stumped.

Nicknamed Fagot by NATO, the MiG-15 is a single-seat, swept-wing, Soviet air force jet fighter that was designed to intercept high-altitude strategic bombers. On December 30, 1947, a MiG-15 prototype made the first official test flight, and in the next nine years, more than 15,000 MiG-15s were manufactured in the Soviet Union, Poland, Czechoslovakia, and the People's Republic of China. At one time deployed in 15 countries, including the former East Germany, Egypt, Iraq, and Cuba, the fighter is perhaps most famous for dueling with U.S. Air Force North American F-86 Sabres during the Korean War.

The Museum's MiG-15 is free of the bullet holes and battle scars that could be expected if it had flown in combat, so it is not likely that the aircraft tangled with F-86s in the skies over North Korea, but Lee doesn't know for sure. Unfortunately, a key piece of information is missing. "There should be a little metal plate that gives the serial number for the airplane," he says. "If we can find it, the plane probably has a few more stories to tell us. It is possible that for whatever reason, between the time it was built and the time we got it, someone pulled the plate off." What Lee does know is that the MiG formerly belonged to the People's Republic of China, but he does not know when and where the fighter was manufactured, nor does he know the military units to which it may have been assigned.

The MiG-15 became part of the Museum's collection in 1986 after Robert C. Mikesh, a now-retired aeronautics curator, arranged to trade three surplus U.S. Navy T-28s for a MiG-15 that the Champlin Fighter Museum in Mesa, Arizona, had purchased from China in 1985 for $130,000. The MiG was loaded onto a commercial Chinese freighter, which set sail across the Pacific on September 9, 1985, and arrived in Long Beach, California, about a month later. It was then trucked to Marine Corps Air Station El Toro in California. On January 7, 1986, the MiG was loaded into a C-5A and flown to Andrews Air Force Base in Maryland, then driven to the Museum's Paul E. Garber Preservation, Restoration and Storage Facility.

Now, 13 years later, the MiG sits in Garber's Building 10, wedged behind the enormous tail section of the *Enola Gay*, the Boeing B-29 that dropped an atomic bomb on Japan during World War II. Garber restoration specialist Bob Padgett (below) is cleaning the MiG and painting it with an anti-corrosion agent. The underbelly of the fighter is so badly corroded, though, that Padgett will replace the skin there. While working on the MiG, Padgett has been searching for the plate with the serial number, but he doesn't really expect to find it. Based on the craftsmanship that he sees in the MiG, Padgett believes it was manufactured in the former Soviet Union, and he thinks it is likely that the Soviets removed the serial number before turning the aircraft over to China. Padgett also thinks, based on the wear and tear that he sees in the engine, that the MiG logged a fair amount of flying time.

ERIC LONG

While the Museum's MiG-15 may not have an illustrious flight record (Lee thinks the Chinese probably used it as a trainer), it is—with its stubby, hollow nose, swept wings, and prominent tailplane—representative of the technology and look of early jet fighters. And though the MiG was probably manufactured in Russia, it has German roots. After World War II, German engineers who had been working on a jet fighter for their own government found themselves suddenly without an employer. So the Soviet Union offered several thousand engineers and technicians security and employment in exchange for their expertise. Among the


ROBERT REEDER

On August 30, 1999, the National Air and Space Museum received a one-of-a-kind delivery from Federal Express: the Breitling Orbiter 3 gondola. In March the gondola, lifted by a dual balloon filled with hot air and helium, carried Bertrand Piccard and Brian Jones on the first nonstop around-the-world balloon flight, which lasted 20 days. FedEx flew the orbiter free of charge on an MD-11 jet from Paris, France, to Newark, New Jersey, where it was put aboard a flatbed trailer and trucked to the Museum. At 6 a.m., Museum employees Bernard Poppert and Rob Mawhinney and FedEx courier Eric Feazell (left to right) helped move the orbiter into the Museum's west end. The history-making craft is now on permanent display in the Milestones of Flight gallery.

German aeronautical designers exported to Russia were many who had worked for the Luftwaffe on airplanes, including noted German designer Siegfried Günther, who is thought to have worked on the MiG-15.

Whatever its origins, the MiG-15 was a superb airplane, able to outperform any of the American-made piston-engine and first-generation jet aircraft (such as the F-80) that challenged it during the Korean War. It wasn't until early 1953, after F-86 Sabres had been on the scene, that the United States achieved complete air superiority. The two fighters were fairly evenly matched, though the MiG had a faster climb rate, higher operating ceiling, and tighter turning rate at altitude. But the Korean and Chinese pilots who flew MiG-15s were no match for the far more experienced and better trained Sabre pilots, who started downing MiGs at a prodigious rate.

Though the Museum's MiG-15 is not currently scheduled for a full restoration, it will be ready for display when the long-planned Dulles Center opens in 2003. Museum curators have allocated space for a grouping of Korean War-era aircraft, including the MiG, a Grumman F9F Cougar, a Yak-9, and the MiG-15's old enemy, the F-86. Lee acknowleges that without the MiG's serial number, the fighter's history may never be pieced together, in which case it can serve only as a representative of its type. Still, that's not such a bad assignment, considering the impact that the MiG-15's innovations had on aerial warfare during the Korean War and since.

*—Z. Byron Wolf*

## MUSEUM CALENDAR

**December 2** "In Search of the *Liberty Bell 7*." Salvage expedition leader Curt Newport will talk about the recent recovery of Gus Grissom's Mercury space capsule from the bottom of the Atlantic Ocean. Langley Theater, 7:30 p.m.

**December 11** "The Christmas Star." Take a tour of the winter sky and view a triple conjunction of the planets, Halley's Comet, and a nova, which has been suggested as the source of a Christmas Star. Einstein Planetarium, 6 p.m.

**January 29** "Leftovers and the Eve of Destruction." Harold Geller of George Mason University will talk about the likelihood of collisions between Earth and asteroids. Einstein Planetarium, 6 p.m.

**Space Fiction Film Series**
Jan. 7, *E.T. the Extra-Terrestrial*; Jan. 14, *Star Trek: Insurrection*; Jan. 21, *Men in Black*; Jan. 28, *The Abyss*. Langley Theater, 8 p.m. Tickets ($3.25 per show and $10 for the series) will go on sale December 29 through PROTIX, phone (800) 529-2440, and on the Web at www.protix.com.

*Except where noted, no tickets or reservations are required. To find out more, call Smithsonian Information at (202) 357-2700; TTY (202) 357-1729.*

## Remembering Don Engen

Before he lost his life in a glider accident on July 13, 1999, Donald D. Engen had a long and varied career, which included distinguished tours with the U.S. Navy, Piper Aircraft, and the Federal Aviation Administration. Engen's final job was serving as director of the National Air and Space Museum, where he made it his top priority to raise the funds necessary to build the long-planned Dulles Center, which will house some 300 air- and spacecraft. In his autobiography *Wings and Warriors: My Life as a Naval Aviator*, he wrote: "Early every morning, as I enter the National Air and Space Museum's empty and quiet great halls, which will soon be filled with thousands of visitors, I savor the cool air and walk among the many aviation and space exhibits in awe." We can only imagine the awe and satisfaction that Engen would have felt had he lived to see the completion of the Dulles Center.

So far the Museum has raised $92 million of the $130 million required. If you would like to contribute in memory of Engen, you may send a donation to: Donald D. Engen Memorial Fund, National Air and Space Museum, Room 3509, MRC 0321, Independence Ave. at Sixth St. SW, Washington, DC 20560-0321, or call (202) 357-4487.

COURTESY MARY ENGEN

# The Undertakers

Florida's Cape Canaveral had two primary features that promoted its selection as a missile test laboratory in the 1950s. First, its flight range was over the Atlantic Ocean. Second, that ocean contained a string of small islands that could serve as tracking bases when test missiles flew over. But when something went wrong during a missile flight, the ocean floor became the missile's last resting place.

At the height of cold war rocket testing, the Cape saw the launching of as many as 287 missiles in one year. In one 24-hour period, the U.S. Air Force, Army, and Navy fired eight major missiles. Many of these developmental attempts were failures, as missilemen learned their art through trial and error. The ear-splitting noise and blinding flash of a dying rocket plunging into the ocean in pieces became common occurrences.

When an intercontinental or intermediate-range ballistic missile fell into the ocean, its precious flight data went down with it. The nation's security depended on rapidly locating and salvaging the test vehicle to determine what went wrong. On call was a small group of commercial divers and underwater recovery specialists, nicknamed the Undertakers. The divers rarely went wanting for work.

The company name was Lou Berger Divers Inc. Though Berger owned the company, Vern Nealy, diving superintendent and manager, was its soul. Cape missilemen once bragged of having rocket fuel in their veins; Nealy's blood was pure saltwater.

Nealy had worked as a diver on a glass-bottom tourist boat in Miami's Biscayne Bay. Using an open-bottom copper diving helmet, he would scam the tourists by selling them seashells he claimed to have plucked from the bottom of the bay. But shells do not occur naturally in Biscayne Bay. Nealy hid shells from Florida's west coast in a bag on the boat's keel.

In 1954 Berger was awarded the Air Force missile recovery contract for the Cape and missile test ranges. Lou Berger had met Nealy on the tourist boat and asked him to come work at the Cape. Unknown to the Air Force, the duo's limited scuba and open-bottom helmet diving experience were the sum of their salvage background, but in those days, diving, like rocket engineering, was an art that one learned as he went along.

After hiring a few former Navy demolition divers and several commercial divers, and getting the use of Air Force crash boats, the Undertakers got their first job in October: the recovery of a Snark cruise missile that had fallen in 50 feet of water just off the beach. Launch crews had watched it go into the water, so locating and salvaging the errant Snark proved relatively easy. When divers arrived at the site, bubbles and hydraulic fluid were still oozing up from the remains. The Berger Divers picked up debris and marked the site with buoys. Later, with Nealy doing the rigging, the wreckage was slung and hauled up with a crane. Subsequent efforts to recover other wayward missiles were less straightforward.

In the mid-1950s the frequency of missile launches on the Cape rapidly increased. The Army attempted to perfect its Redstone and Jupiter missiles and the Air Force struggled to get its balky first ICBM, the Atlas, and later the Titan, into operation. The Navy, struggling with its Polaris missile, was not having much more luck.

In operations with the military services at the Cape, Nealy worked out a general drill for missile recovery. Before any launch, crash boats and dive crews waited offshore to speed to the impact site should a failure occur. Onshore, two theodolite cameras tracking elevation and azimuth would follow the flight. Tracking radars from the Cape, the FPS-16 radar at nearby Patrick Air Force Base, and downrange radars on the islands also followed the rocket. The offshore boats could also use their own navigation radar to see the splash if a rocket landed in the water at night. To help with sighting the rocket if it fell near shore (as they often did), Nealy and a Coast Guard sailor would stand atop the Cape Canaveral lighthouse, which was only a few thousand feet from the launch pads. Using a small telescope, Nealy could get an additional azimuth fix on the crash site and guide dive boats to it by radio.

This system worked well until the Army suffered the first launch failure of the Jupiter IRBM. The rocket rose from the pad and promptly went off course. The range safety officer detonated the missile but the parts headed for the lighthouse. Nealy told me: "We were standing there transfixed, watching the

COURTESY VERN NEALY/USAF

COURTESY VERN NEALY/U.S. ARMY

*A U.S. Army Redstone missile on a range and accuracy test departs Pad 26 at the Cape (opposite) for the waters off Grand Bahama Island. Standing by to retrieve the military's early missiles—or their remains—was a group of hardy divers in woolen long johns and sneakers led by Vern Nealy (above).*

thing with our mouths agape like idiots—not that we could go anywhere. It blew up between us and Hangar C [300 feet from the lighthouse] and took all the windows out of the hangar. [The blast] hit us in the face like a big feather pillow. After the explosion the Coast Guard guy and I ran around the top of the lighthouse and got in to run down the stairs, only to realize that we had a ton of glass Fresnel lens over our heads." (Fortunately, the lens stayed intact.)

Days later a Thor missile launch blew up while Nealy was on the lighthouse, sending him and the sailor again searching for scant cover. Nealy opted to return to the relative safety of diving.

Diving in Cape waters is nothing like diving in the clear seas of South Florida. The bottom is covered with an adhesive clay-like soil called Blue Mud. Visibility near shore is often zero and the waters are cold most of the year. Wet suits didn't exist in those days, and the divers didn't like wearing the warmer but cumbersome commercial dive rigs. These were fine for underwater construction, but for searching great distances they were an encumbrance. Instead, the Undertakers wore the woolen long-johns supplied for the heavyweight diving suits, which provided insulation for short periods. They used a full-face rubber Desco mask, which was supplied with air from a surface compressor through an umbilical.

So outfitted, and with tennis shoes and weight belt (an Army cartridge belt with lead added), crews could search about a quarter square mile a day for a lost missile. Often test rockets blew up at altitudes of thousands of feet, and, depending on wind and currents, the debris could cover a wide area. Usually the military wanted the engine parts only, and the search area could be narrowed.

But when a search was extended due to the scattering of parts, the divers suffered dreadfully from the cold. They would walk the bottom for a short while, then surface and lay on the diesel engines of the crash boats to get warm. When they had stopped shivering, they again rigged up and went back in the water. These efforts went on 24 hours a day, and the divers sometimes suffered from exposure.

Eventually the Berger Divers expanded operations to the warm, clear waters of the Bahama Banks. In the late 1950s, the Army Ballistic Missile Agency fired 12 Redstone missiles downrange from the Cape into shallow water north of Grand Bahama Island near Mangrove Cay. The Army wanted the Undertakers to locate each missile's dummy warhead and mark it with a beacon and strobe light so the Redstone's exact range and accuracy could be determined. A radar-equipped telemetry barge was anchored three miles from the predicted impact point to locate the splash the warhead made as it hit the water. The divers anxiously waited near the barge and, when notified that the vehicle was down, raced to the site.

The waters were so clear that the crew of a Boeing B-17 assigned to the project could spot rocket debris on the seabed. Nealy often accompanied the air crews on these flights, so he could guide his divers to the impact site by radio. One day, in an effort to get a jump on the mission (and make beer call at the officers' club), the B-17 pilot importuned Nealy to arrive at the impact area before the Cape could give the all-clear.

They had just left Mangrove Cay, 10 miles from ground zero, when the Cape notified them that the first Redstone had left the pad. Knowing how long it took the rocket to reach the predicted impact area, the air crew started timing the flight. Flying straight into the impact zone, the B-17 crew, with Nealy on board, passed the telemetry barge and dive boats too early.

Realizing too late that he was inside the three-mile predicted impact area, Nealy, the hair on the back of his neck rising, was about to ask the B-17 pilot to turn around when the Redstone's reentry shock wave shook the aircraft. Less than a mile in front of the B-17, the warhead's massive impact splash blossomed up from the ocean. The pilot veered hard to the right; nevertheless, water droplets struck the airplane's port windows.

Vern Nealy now lives in quiet retirement not far from Biscayne Bay. As I listened to him reminisce, I came to doubt that the modest diver or his Undertakers would lay much claim to having helped launch the Space Age or win the cold war. But they did both.

*—Gary L. Harris*

# The Last Laugh

In 1949 the U.S. Navy and Air Force were in a dogfight over the role of carrier aviation versus that of the Strategic Air Command as represented by the Consolidated B-36. The Navy said the B-36 was extremely vulnerable to fighters. The Air Force said that carriers were easily found and disposed of by air power. (A few years later, I discovered that carriers were not all that easy to find, even with functioning navigation aids and a perfectly clear sky. One unforgettable day I finally found the carrier and landed with what I estimated was about 10 minutes of fuel left.)

I remember seeing—but mostly hearing—great lumbering Convair B-36s fly over my home in Clarksville, Tennessee, before I joined the Navy. The pulsing sound of their six piston engines and four jets sounded like a monster electric fan. You could tell that a B-36 was flying overhead even if you weren't able to see it through the overcast.

After earning my wings at Naval Air Station Pensacola in Florida in early 1953, I was assigned to VC-3, an all-weather night squadron that furnished night fighter teams to carriers in the Pacific fleet. At the time, VC-3 was deploying teams in either Vought F4U-5N Corsairs or McDonnell F2H-3 Banshees.

After flying the F4U and the SNB-5 Twin Beech, I checked out in the F2H-3. It was a nice-flying single-seat airplane, but its 25,000-pound gross takeoff weight was vastly underpowered by two Westinghouse J-34 WE 34 engines of (gasp!) 3,250 pounds of thrust each. To me, its performance was considerably less sterling than that of the T-33 jets I'd trained in. It flew like a Cadillac with a Volkswagen engine. The radar and other avionics were probably worth much more than the airframe.


WAYNE SHIPP

I was in the San Francisco area a few flights into my checkout, operating out of Moffett Field, when a B-36 hove into view about five miles away. It was at 25,000 feet, and in those days, just about the only aircraft that flew at those altitudes were military and hence fair game for a bounce. That, of course, is exactly what I decided to do—if a pass in a Banshee could be called a bounce. My loyalty to the Navy and naval aviation knew no bounds: I would demonstrate that the B-36 was indeed a loser as a cold war weapon.

The first pass was what I considered a classic. I swept by the giant, which responded like a water buffalo being approached by a mouse: not at all.

Okay, this called for a little formation work. I would fly up alongside and with a certain hand signal I would register my disdain for such a BUFF—Big Ugly Fat Fellow.

As I pulled up from behind and to its left, I slowed the F2H but sailed rapidly past the huge bomber. I turned back and set up an approach with flaps and landing gear down to lower my speed. I slowed to near stall speed, but again sailed right by it.

The third time would surely be the charm. I slowed up to—and below—stall speed. Simultaneously I realized that when I started the passes the Air Force pilots had gradually slowed their bomber. Later I heard that a lightly loaded B-36 could fly perfectly well on just its piston engines at an indicated airspeed of only 100 mph.

I can tell you without fear of contradiction that the spin recovery procedure for a Banshee works precisely as detailed in Navy document CO-01245FBC-1A.

I never saw the B-36 again, since making up the 15,000 feet I lost would have required more time and fuel than I had available.

Somewhere in this great nation, many years after the fact, I'll bet there are two B-36 pilots still laughing themselves silly.

*—William K. Kershner*

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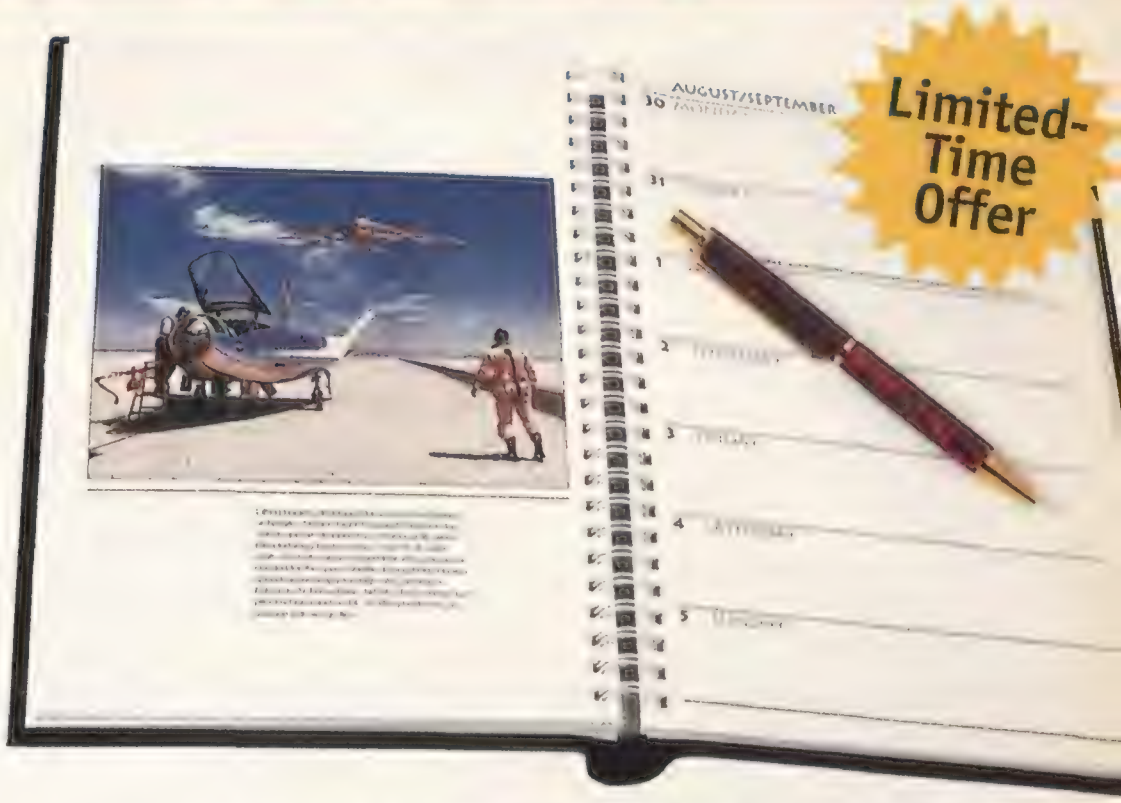


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# Fifteen Feet and Closing

*Before closing these North American T-28s into a tight diamond formation, the pilots practice in a far less treacherous environment (opposite).*

## At formation flying school, invading your neighbor's space becomes an art form.

by Debbie Gary *Photographs by Tim Wright*

On a May morning we are high above the Mississippi Delta on what looks like a collision course with another airplane. It is a spot on the horizon, which gets bigger and bigger until it fills our windshield, then whooshes overhead as we slide under it.

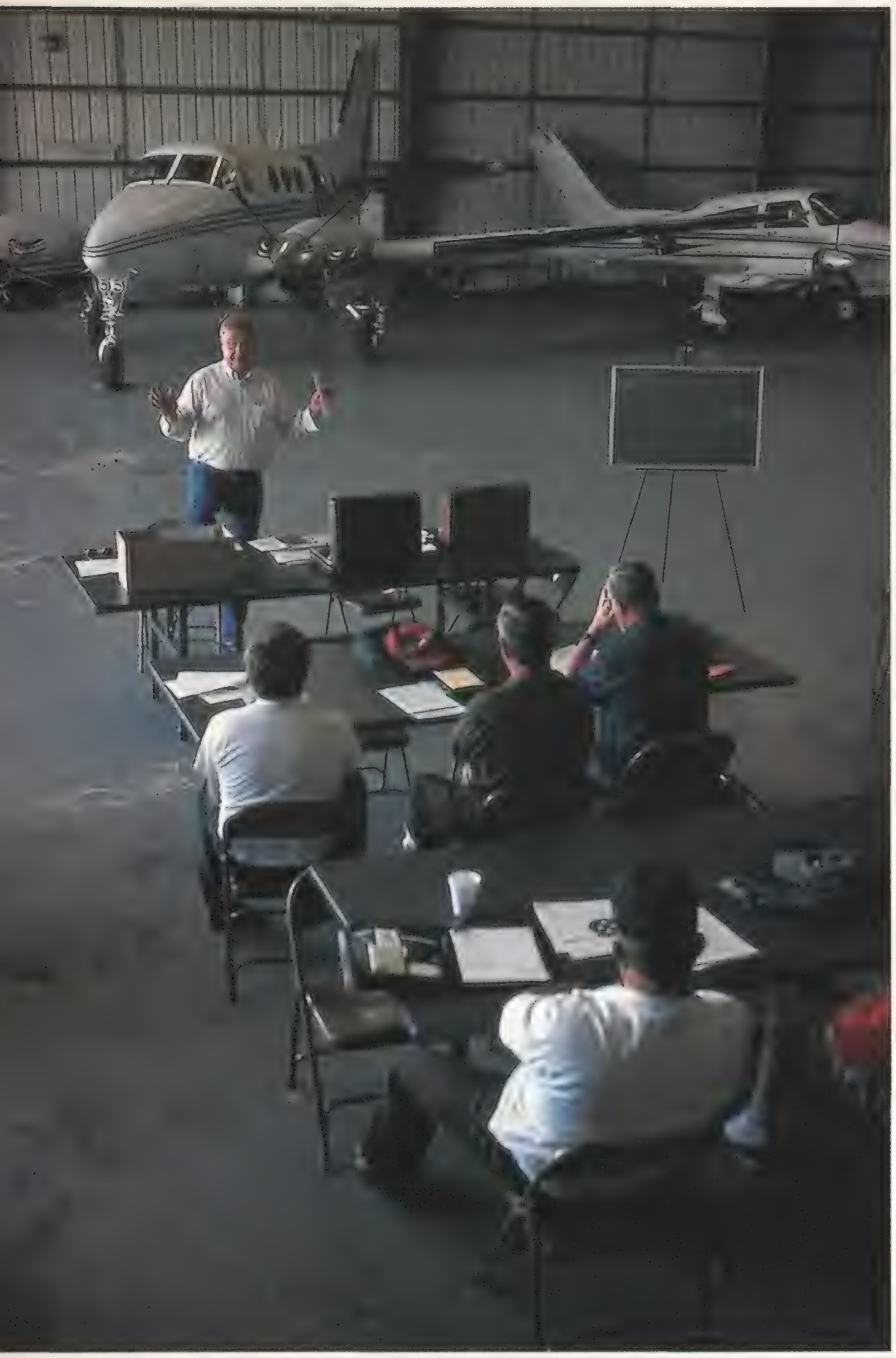
Terry Calloway is learning formation rejoins. He is one of the 94 general aviation pilots attending a formation flying clinic at the Greenwood-Leflore Airport to practice an art that is primarily the domain of military fliers and the few who fly formation aerobatics for a living.

It's hard work making airplanes perform in harmony—wings perfectly aligned, speeds evenly matched, every dive and turn synchronized. When gracefully flown, formation is a pleasure to watch and delightful to perform. But when awkwardly flown, airplanes bob and weave like clumsy dancers, and the danger of a collision looms large. Pilots who arrive here as novices will depart with some 20 hours of solid formation flying practice. They won't be experts, but they will have learned how to focus their attention and effort on holding position a few feet from another airplane.

The clinic is four days of intense flying, all-day training, endless storytelling, and after-hours partying, all hosted by Vernon Ricks and a tax-exempt corporation called The Airmen. Ricks has been putting this on for his friends for the last 26 years. The participants are a mixture of novices and experts, civilians and military men, who have come to learn, to relearn, to teach, or to practice. The names, faces, and even title change with the years; this year it is Vernon's Pilot Party, a Yak Club Regional Formation Event (last year it was the Greenwood Formation Clinic).

As a kid, Ricks was inspired by the formations of Stearmans, Vultee BT-13s, and Republic P-47s that flew at Greenwood Field, an Army Air Corps base. He planned to be a military pilot, but first he began cropdusting in a Stearman. Flying from the airport to farm fields every

# echelon...trail...diamond...vic...



*Vernon Ricks brings students up to speed with coffee and the formation flight manual in the Kimmel Aviation hangar.*

day, he learned formation from a fellow cropduster.

While dusting one morning in 1959 his military flying dream was shattered, along with most of the bones in his body. As he flew under low-level electrical wires, a flock of blackbirds enveloped his airplane, blinding him. The Stearman slammed into a levee. "It crippled the fuselage behind me and nearly tore off one of my feet," he says.

Ricks spent a long time in the hospital and on crutches. "I felt embittered, singled out, and hurt," he says. "Then, one day in the early '70s I woke up. I was lucky to be alive and I felt like I owed in some way. Somebody ought to help people learn formation flying. Why not me?"

When I land at Greenwood in my Super Cub, I am directed to Kimmel Aviation, where I park among T-28s, L-39 jets, SIAI-Marchetti Sf.260s, Glasair IIIs, Bonanzas, Yak-52s, T-34s, T-6s, a Stearman, a Great Lakes, and a Navion. Ricks' wife Valley is greeting and registering participants and collecting the $100 fee that covers cold drinks, lunch, and dinner in the hangar or poolside at the Ricks house.

Before long, pilots are out front admiring one another's airplanes. Ron Wasson, an American Airlines pilot, is here with his CJ-6A, a Chinese military trainer. "Where I live, in Colleyville, Texas, there is only one of them—mine. Here there are four," he says. "I flew thousands of hours of formation in C-130s in the Air Force, but now I fly 727s for a living. If you bank more than 10 degrees, the little old lady in the back is screaming bloody murder. So I'm here to do some four-ship formation." James Goolsby, another CJ pilot, nods. He flies for United Airlines and learned formation flying in the early 1960s in a Piper Cub when he first started flight instructing. He will act as a check pilot at the clinic. All the instructors are volunteering their time because they love flying formation—talking about it, teaching it, and hanging out with other formation pilots.

This year's clinic begins on a Wednesday morning and ends after a catfish fry on Saturday night, but pilots fly in and out all week. Some just come to visit friends. Some stay long enough to take a check ride to renew their Formation and Safety Team card, which qualifies them to fly non-aerobatic formation at airshows. Others, serious about polishing their skills, will accumulate 15 to 20 hours of formation practice. Some, like Terry Calloway, Stu Goldberg, and Ritchie Jones, have never had any formal formation instruction. Others, like Scott Patterson, a retired Air Force Wild Weasel squadron pilot, and Mark Lauritzen, a retired Marine and former Blue Angel, used to fly formation for a living.

Training begins with a morning briefing for the newcomers in Kimmel Aviation's huge hangar. At 8:30 a.m. they are spread

along tables drinking coffee or leafing through their textbook, the T-34 Association's formation flight manual.

Ricks, a tall, silver-haired man with a booming voice, describes the lay of the land: level farmland to the west, hilly woods to the east, radio towers in various quadrants. The landmarks called Cotton, a bunch of warehouses, and Gator, the swamp, will be Initial Points—IPs—where flight leaders will report their positions to the Greenwood control tower.

Ricks also sets the tone of the week—this is work, not play—and talks to the participants about getting the most out of their time here. He wants them to fly four times a day. "Don't dawdle when you could be flying," he says. "If you want to talk to your buddy, talk to him tonight." Then he talks about getting FAST-rated.

Pilots who want to fly formation in airshows must have a formation card issued and renewed annually by one of three organizations: FAST, the Formation and Safety Team; the International Council of Airshows; or Formation Flying Inc. FAST is for warbirds, ICAS is for aerobatic fliers, and FFI is for everyone else.

There is no formation rating outlined in the Federal Aviation Regulations, and there

*A disparate air force assembles for the clinic at Greenwood airport, from glamorous L-39 jets to plain-vanilla Bonanzas (above). Instructor Kim Pruyne demonstrates a maneuver in the common language of fliers everywhere (left).*

is no civilian rating that requires formation flying skills. But since pilots were choosing to fly formations at airshows, ICAS decided that something needed to be done to standardize this type of flying.

Until then, all the warbird groups had their own sets of rules, terminology, and hand signals, some based on Navy procedures, some based on the Air Force, some invented on the fly. Airshows that launched gigantic formations included pilots from these diverse groups. FAST was born in 1993 to standardize the practices of a conglomerate of warbird organizations, such as the Confederate Air Force, the

GEORGE HALL/CHECK SIX

*Because it affords protection against enemy aircraft, formation flying got its start in the military. Above, A-4M Skyhawks close ranks.*

Valiant Air Command, Warbirds of America, and the Yak Club. FAST is the only group with an established training program. Ricks' clinic follows FAST procedures.

Because FAST is a warbird organization, its cards apply only to warbird-type airplanes with a low wing and a bubble canopy. More than half the pilots at Ricks' clinic are in civilian aircraft. Thirty-nine of them fly Bonanzas.

Until recently, a Bonanza was the most unlikely formation-flying airplane imaginable. It is the Volvo of the flying world, a roomy, stable, fast, cross-country single-engine airplane. But in 1990, Bonanza pilot Wayne Collins started an annual event called Bonanzas to Oshkosh, a mass flight to the Experimental Aircraft Association Convention in Wisconsin. Now Bonanza pilots all over the country want to become formation pilots. They could get a card from Formation Flying Inc. in Round Rock, Texas. But FFI doesn't teach, it only gives exams, so the Bonanza pilots come to Ricks.

Because Ricks has put on a lot of these clinics and has heard pilots grumble, he gives them fair warning. "Don't take the critiques personally," he says. "Don't put your feelings up on your shoulder. The pilots who are flying with you are ex-military or professional, fly-for-hire pilots, so you are going to hear from them, especially if you do some dumb things."

After Ricks' briefings, Kim Pruyne addresses the newcomers. A retired Air Force pilot who flew big transports and hurricane hunters, Pruyne drills them on formation discipline, terminology, procedures, and hand signals. He covers the formation flying manual in detail, reviewing

# acute...station keeping...

terms like "station keeping" (holding position), "sucked" (too far back), "acute" (too far forward), "gimme some" ( a call from the wingman to the leader to reduce power), "pitch-outs" (breaking away from the pack), and "kiss-off" (split up to land), as well as formations like fingertip (four aircraft arrayed like the fingertips of one hand), echelon (all wingmen on one side of a lead aircraft), trail (one after the other), and diamond (see photo, p. 26).

Formation flying evolved during World War I as a means of mutual protection for aircraft venturing out to reconnoiter. A lone scout, concentrating its attention on ground forces and unaware of threats from the air, would be vulnerable to attack. But with another along to watch for fighters, chances of survival rose. Soon the principle of safety in numbers led to gaggles of defending fighters gathered around a leader for the protection of one or more scout aircraft performing reconnaissance or adjusting artillery fire. Between the wars, a more ceremonial kind of formation, the aerial parade or air tattoo, entertained crowds at celebrations.

Although the civilians at formation flying school aren't looking for enemies, they must fly with a military-like strictness. "Formation discipline means you do what you said you were going to do," says Pruyne, business-like in his flightsuit. "Don't get a harebrained idea while you are in the sky. You can change things, but the idea is to talk about what you are going to do. Formation discipline says you do what the leader says, not what you want to do. One of the things most leaders tell you to do is to shut up, mostly." This is one of the fundamental tenets of professional formation flying: Shut up and fly. Neither explain nor complain. Make no excuses.

There is one more drill. Pilots must walk through their upcoming flight, responding to the leader's waves, hand pumps, elbow bends, and pointed fingers as if they were all airborne. The students line up, four to a group, and try not to feel silly as they walk around the ramp in flightsuits and shorts. When they can perform an imaginary flight impeccably on the ground without turning the wrong way or crashing into each other, they are ready to fly.

Now formations take off. While they are gone, the wind picks up—across the runway. Most of the formations make a pass down the runway when they return, crossing the threshold at several hundred feet, with one, two, or three airplanes in right echelon formation off the leader's wing. Mid-field, lead gives the kiss-off signal, racks his airplane into a tight left turn, and peels off toward the downwind leg of the runway entry pattern. The others follow suit and land well spaced out.

The Bonanzas, however, follow a different procedure. Since they are training for their en masse arrival at Oshkosh, they must learn to land in formation. The first Bonanza formation that returns today is landing in "vic," a V-shaped formation, with the wingmen on either side of lead. Perhaps they don't see that the wind has picked up across the runway.

An airplane wing generates turbulent air, which normally streams behind its wingtips like horizontal tornadoes. When pilots fly close formation they learn to steer clear of these corkscrews. When the wind blows down the runway they flow straight back behind each airplane. But today the wind blows these vortices across the runway, from the Bonanza leader toward Elliott Schiffman on the left. The lead aircraft lands smoothly, and the right wingman is settling down. But Schiffman is caught in their vortices. His airplane begins to roll to the right, toward the other airplane. He fights for control, then finally realizes he has to slam the airplane onto the runway to stop the roll. He does—and blows a tire.

"It flipped my wing," Schiffman says later of the turbulent air. He is an orthopedic

TED CARLSON

*SH-60B Seahawks dimple the Pacific in a V formation. With all those whirling rotor blades in close proximity, helicopter formations are among the diciest.*

*Guy Moman Jr. takes a breather on the wing of his Yak-52 (top) and swaps flying stories with the author, in the cockpit. Above, Bonanzas practice a vic formation while a fourth flies as photo ship.*

surgeon and apparently is used to thinking calmly under pressure. "I had full left rudder, full left aileron, and I was helpless, drifting to the right toward the plane on my right. It was like skidding on ice. All of a sudden you are along for the ride. You try, but the forces are more than you can control."

In 1973, I learned the same hard lesson, landing in formation at the Du Page County airshow in Illinois and dinging a wing. I flew formation aerobatics for four years and learned never to let my guard down near the ground or when close to another airplane. Even when your attention is riveted on the airplane in front of you, things happen fast.

## gimme some...

During the week I'm in Mississippi, I fly with a number of pilots: Guy Moman Jr. in his Yak-52, Ritchie Jones in his flying club's Bonanza, Bill Billups in the Glasair III he built, Steve Leonard in his SIAI-Marchetti, Terry Calloway and Stu Goldberg in their Bonanzas, and John Murphy in his L-39. Even though I have thousands of hours of formation flying experience, I am just like the other students, intoxicated by the magic of sailing through the air so close we can see one another's grins.

Back on the ground, I stroll through the hangar to listen to debriefs. The cheery nervousness of the morning has given way to serious discussions. Everyone makes mistakes, and they are analyzed, in excruciating detail, so everyone can learn from them. There are long faces and disgruntled looks from men who are surprised to learn how many mistakes they could make on a one-hour flight. Flying that one considers crisp and precise is labeled by another rough and impossible to follow. The training is tough—and hard on the ego.

The lead pilot must lift off the runway gently so the other pilots can follow him. He must roll into his turn smoothly or his wingmen are caught off guard. Safety pilots debrief their charges. "What speed did you use on liftoff?" one of them asks. The pilot mumbles something. "Well, keep it on the runway longer next time and lift off smoothly. Lead has got to think about the guys behind him. Look at both your wingmen before you roll into a turn. Make sure they are looking at you."

Rejoins are one of the hardest and sometimes most breathtaking maneuvers formation pilots learn. It takes experience to gauge how fast you are overtaking the lead airplane and even more experience to slide into position without overshooting. Wingmen, afraid of moving toward lead too fast, creep too slowly. Bolder beginners overshoot and have to make their airplanes slide under the leader. Most aircraft have no air brakes, so moving toward another airplane for a rejoin, then stopping exactly where you want to be, takes lots of practice—and lots of mistakes.

Pilots are taught about trajectories, cut-off angles, and fixing the other airplane in a spot on the canopy and watching the rate at which its image grows. "If he starts going back, you are going to have to roll out, or you are going to go acute on him," safety pilot Scott Patterson explains. "Roll out, then slide back. Or, if he starts going

up on you, get back on the line."

"Remember, the lead is cutting one big circle and you as wingmen are cutting smaller circles on the inside of that," says Randy Hatchell, another safety pilot. "So what you want to do is basically parallel exactly what he is doing, then slide in."

Later I fly with Stu Goldberg in his Bonanza. "Watch the rate at which the other plane gets bigger in your windshield," I say, "then pull off your power and watch for that rate to slow up. You have to really concentrate. Try to see the moment when it looks like his plane hangs in the air. Add the power back right there, because in the next instant he'll start moving away from you."

Patterson and Hatchell have been flying with Dick Schmidt and Bruce Holecek, who have their own L-39s and are new to formation but have spent 10 or 20 hours practicing together. Patterson and Hatchell explain the mechanics of rejoins to them. Schmidt looks impatient and says, "That is something that we really understand, but I just have trouble doing."

"This is a learning school and everybody has trouble doing it until they have done it a lot," Patterson says. "It is not something that comes natural."

"I'm batting about 60 percent," Schmidt says.

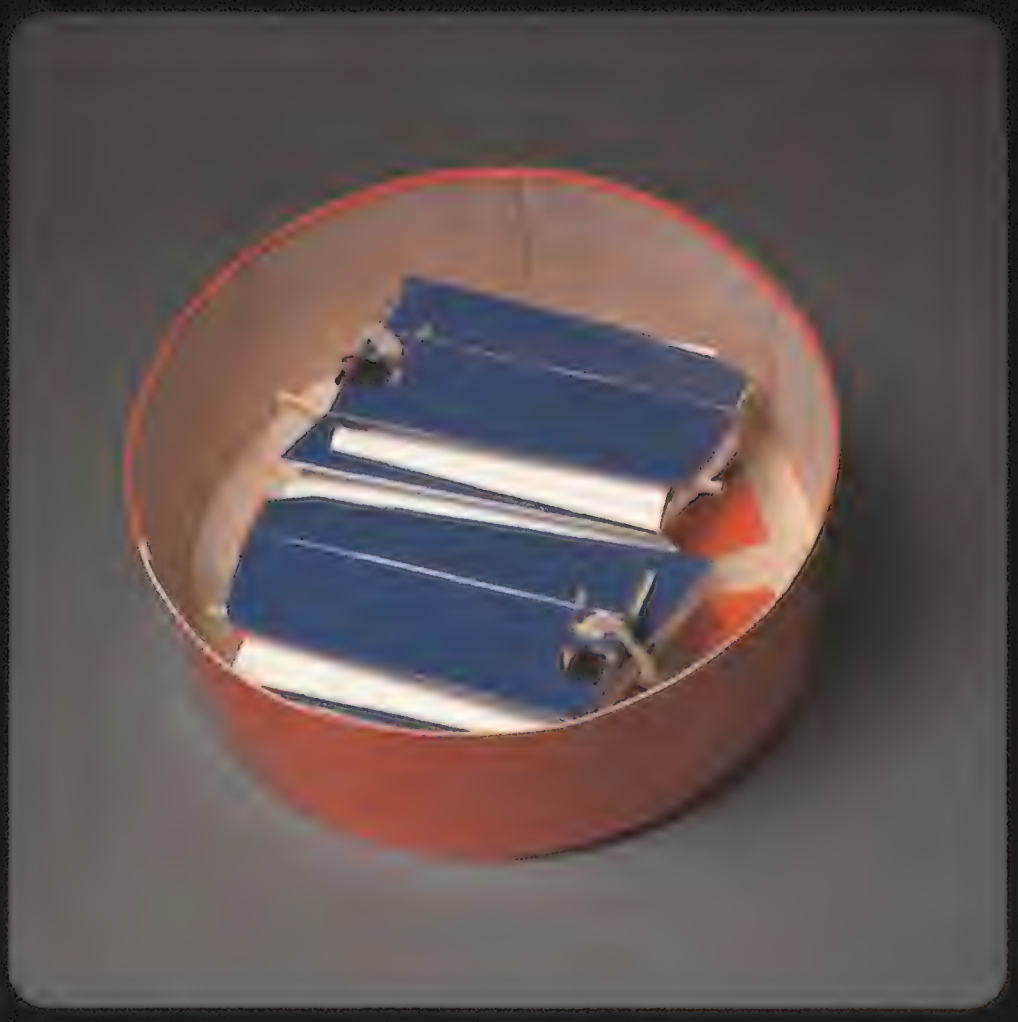
The debrief goes on for an hour, each facet of the flight meticulously examined. All over the hangar it is the same: various stages of bewilderment, annoyance, exasperation, and perspiration. The only ones beaming are the military pilots, who seem to have dropped 10 years from their faces as they dig into their memory banks for the years when they were younger and did this every day.

On Sunday a few people slip out early, but many linger. Schmidt and Holecek are still flying with instructors, trying to get the most out of their time here. Before they finally leave, they decide to meet back here in October with all the other L-39 pilots in the country.

Some, like Ritchie Jones, Sean Davis, and Glen Wimbish, know they will get together back home to practice. Others, like Steve Leonard, hope they will find someone with a similar airplane and experience. Clyde Zeller, who instructed all week, says, "People found it harder than they thought it was going to be, like boot camp. Thirty years from now, when they see each other they'll say, 'We were at Greenwood together.' "

DOYLE R. BUEHLER

*Students may never achieve the perfection of teams like the Snowbirds (top), but they will log 20 hours of solid practice here.*



# Mars Air

## How to build the first extraterrestrial airplane.

*by Oliver Morton*


As a monument to the aerospace century, the idea could hardly be bettered. A hundred years to the day after the Wright brothers took off from Kitty Hawk, the first aircraft built for another planet would fly through the light pink skies of Mars. A technology that had girdled and transformed one world—Antarctica is the only continent without contrails regularly dissecting its sky—would begin afresh on a second.

Right from the start, the idea stirred powerful emotions. NASA Administrator Dan Goldin announced in early 1999 his agency's plan to send a little robot aircraft, one of a proposed series of Martian "micromissions," to arrive at Mars on December 17, 2003. More than just an adventure, it would have the benefit of bringing together the normally separate aeronautics and space sides of NASA's house. Unfortunately, what seemed an appealing interdisciplinarity ended up making the project's infancy more troubled, with different factions in NASA fighting over who should do what. At one point responsibility was divided between two research centers on opposite coasts. "It was like the wisdom of Solomon," says one observer, "except that they actually did cut the baby in half."

The baby eventually was restored to one piece, and NASA's Langley Research Center in Hampton, Virginia, was given the go-ahead to start working toward a November 2002 launch. Project managers even got as far as inviting industry to propose ideas for how the airplane should be built. But the goal of meeting the Wright brothers anniversary proved too much, too fast, and by early November the money managers at NASA headquarters admitted defeat. Langley's Mars Airplane project is now on indefinite hold, with launch planned for no sooner than 2004.

Even though the first extraterrestrial airplane flight has been postponed to some less historic date, the Kitty Hawk anniversary has already served to focus attention on the argument that someday, the exploration of Mars will require flight. If a human expedition ever gets under way ("And you and I know that it will," says Joel Levine, the Mars Airplane project scientist, with commendable faith), powered flight could vastly increase its scope. If unable to fly, Martian pioneers will be able to explore the vicinity of their landing site using rovers that cover perhaps a state's worth of territory. With airplanes, they will be able to explore a world. "If we do our work properly," says Marsplane pioneer Dale Reed of NASA's Dryden Flight Research Center in California, "we should have a two-seater airplane available when the astronauts get there 15 to 20 years from now. That's what this whole effort should be leading to."

The idea is not new. Nearly half a century ago, Wernher von Braun described Mars landings using hypersonic gliders—Chesley Bonestell painted one sitting on the dusty Martian plain like a silver arrow. Von Braun might not have bothered, though, if he had known what we know now about the

NASA AMES RESEARCH CENTER

*The problem—how to cram a sophisticated airplane into a tiny container—is still as vexing today as it was in 1996, when this folding model of a Mars glider was designed at NASA's Ames Research Center. The currently envisioned Mars Airplane will have to fit in an aeroshell no larger than a cooking wok. The space constraint is imposed by the Ariane 5 rocket, which will give the 40-pound airplane its ride to Earth orbit.*

Martian atmosphere. Before the Space Age, it was understood to be thin. Just how thin wasn't appreciated until the first spacecraft flybys in the 1960s. The pressure at the planet's "datum"—the notional surface that serves as a sea level on sealess Mars—turns out to be only about six millibars, or six thousandths of the atmospheric pressure at Earth's sea level. Even well below the datum, in the heart of the vast canyon system known as Valles Marineris or in the depths of the Hellas basin, it never climbs much above one percent of Earth's sea level pressure. There is simply not much aero for an aeronautical engineer to work with.

But if the planet's atmosphere was disappointingly thin, the fascinating surface revealed by NASA's three Mars orbiters of the 1970s—Mariner 9 and Vikings 1 and 2—more than made up for the letdown. Some of the landscapes are astonishing: volcanoes the size of countries, canyons that could stretch across continents, flood channels through which a sea could drain in a matter of days. This was clearly a place worth exploring.

After the Viking landings in 1976, aircraft came to be seen as an exciting way of carrying the exploration forward. The pioneers of the Space Age had most admirably solved the problem of reaching other planets, but hadn't been able to move around once they got there. The Viking program, for example, dispatched extremely sophisticated machines to a world millions of miles away, where they inspected only a few square yards of the surface. The attraction of spacecraft that could investigate larger areas at higher resolutions than you could achieve from orbit was obvious. So engineers at the Jet Propulsion Laboratory in Pasadena, California, the center that handles most of NASA's planetary science, began to think about airplanes. Their thinking soon led them to Dale Reed.

While NASA's planetary probes were opening up the solar system, Reed was concentrating on a completely different, if also rather futuristic, problem—the development of supersonic airliners on Earth. One worry, then and now, was that these high fliers might do all sorts of damage to the stratosphere. NASA therefore started a program to measure the environmental impact of supersonic flight by sampling the wake of an SR-71 traveling through the stratosphere at Mach 3. That required another aircraft that could get up to 70,000 feet and take the samples. To meet the requirements, Reed designed the Mini-Sniffer, a small, remote-controlled vehicle powered by a unique hydrazine engine. Hydrazine blows itself apart in the presence of the right catalyst, a trait that has long made it a popular fuel for spacecraft thrusters. Reed's design used heat given off by this reaction to run a little steam engine; that engine in turn drove a propeller.

The Mini-Sniffer thus solved two of the problems facing potential Mars airplanes. It worked in very thin air (though not as thin as that on Mars) and it generated all its power with onboard fuel. This mattered because the Martian atmosphere, such as it is, is composed almost entirely of carbon dioxide. Jets and internal combustion engines wouldn't work there, but Reed's hydrazine steam engine would do just fine. What's more, it could use a fuel that any Mars-bound spacecraft would likely carry anyway.

The fact that the Martian atmosphere is mostly carbon dioxide was also, in a small way, a bonus. At any given pressure, carbon dioxide is denser than the air on Earth, which would increase a wing's lift. The biggest plus of all, though, was the low gravity on Mars, which reduces the wing loading on an aircraft, allowing it to get by with less lift. All

these factors suggested to Reed and to the NASA engineers who approached him in 1978 that Mars flight might indeed be feasible.

"We all got pretty excited," recalls Reed. He and colleagues at JPL and in industry worked on various Marsplane designs based on Mini-Sniffers and sailplanes. The grandest came from an aeronautical engineer named Abe Kerem. It weighed about 1,200 pounds, had a wingspan of about 70 feet, and used a distinctive inverted-V tail. "He likes that inverted V-tail," says Reed. In fact, Kerem's innovation later was incorporated into military unmanned aerial vehicles (UAVs) that evolved into today's Predator, a medium-altitude, long-endurance reconnaissance aircraft that Reed sees as "an outgrowth of this Mars airplane."

The Mars vehicles differed in shape and engine, but they all shared the unusual feature of starting from the top of the atmosphere, not the bottom. During the long voyage through interplanetary space they would be folded up inside an aeroshell like the one that contained the Viking landers. Upon entering the Martian atmosphere the aeroshell would be slowed by a parachute, then would peel away. The still falling aircraft would deploy itself, its wings and tail unfolding as it fell. (In the case of a sailplane-size aircraft, that's a lot of unfolding.) The engine would fire, and powered flight would begin.

BONESTELL SPACE ART

NASA AMES RESEARCH CENTER

*Above: Space artist Chesley Bonestell included an airplane in his classic 1956 painting "The Exploration of Mars," based on the ideas of Wernher von Braun. Left: The 1998 MAGE proposal foresaw the PR value of a Wright brothers anniversary flight over Mars but was rejected by NASA as too risky.*

The other end of the flight seemed as though it would be simpler—at first. "Originally we were just proposing crashing at the end of the mission," recalls Reed. "But then we got the scientists on board and they said, 'Oh no, we don't want to crash. We'd like to use the airplane after it lands.' "

So Reed found a way to convert a sailplane to vertical flight and land it with a rocket. "I took a Schweizer

*Key advances in Marsplane design sometimes come from solving other problems. Dale Reed's Mini-Sniffer (below) flew in the thin air of the stratosphere, sampling the wake of an SR-71. Later Reed showed that a Schweizer sailplane (bottom) could be rigged to make a vertical landing.*

NASA DRYDEN FLIGHT RESEARCH CENTER (2)

sailplane and rigged the tailplane so it would pop up," he recounts. "We towed it up to 10,000 feet and pulled the lever, and [it] came down almost perfectly at a 70-degree angle. The wing goes into a deep stall at a high angle of attack, and it stays controllable—it comes down like a parachute." A Mars aircraft could do the same, switching on hydrazine thrusters in its belly at the last minute to make a rocket-cushioned soft landing just as the Viking probes had done. When it was time to lift off again, the same rockets would kick it back into the sky. Reed's scheme allowed a Mars airplane to fly to a selected landing site, stay there while the scientists back home went over its data, then go on to a second site newly identified as interesting.

The final mission concept that evolved from this work in 1978 was deeply ambitious. Larry Lemke, who has worked on Mars aircraft designs at NASA's Ames Research Center near San Francisco, remembers that the plan called for three spacecraft to enter Martian orbit at around the same time, each carrying four Mars airplanes in Viking-style aeroshells. Each spacecraft would require a space shuttle to deliver it to Earth orbit, and the three launches would have to take place within a period of less than a month to make use of the limited window of opportunity for Mars missions. (Back then, NASA still aimed to fly a shuttle every week or so.) The squadron of twelve aircraft, which might carry a variety of scientific instruments, would fly down to the surface one by one, some revisiting sites of interest spotted by earlier missions. With each aircraft capable of flying perhaps 3,500 miles before landing (1,800 if it used fuel to land, take off, and land again), the mission had the potential to completely circle Mars and explore at least a dozen sites close up, investigating the planet in more detail than ever would have been possible before.

By the time the shuttle actually started to fly—once every few months, if NASA was lucky—it was clear such a grandiose and expensive project would never get off the ground. Mars aircraft were taken off the agenda. But it turned out you didn't have to be thinking about Mars to do useful work on the problem. The key issue involved, in aeronautical terms, is a low Reynolds number. Essentially, this describes the way in which a fluid (air, in this case) flows, and depends on the density of the fluid, the speed of the airflow, and the chord of the aircraft wing. Flying at high altitudes, at slow speeds, or with small wings all translate to low Reynolds numbers. Work on high-altitude research aircraft and on human-powered airplanes like Paul MacCready's Gossamer Albatross taught engineers new tricks that could be applied on Mars. In fact, at least one existing aircraft—the very-high-

AEROVIRONMENT (4)

*Working under contract to NASA's Jet Propulsion Laboratory, engineers at AeroVironment, Inc. built and flight tested a full-scale (five-foot wingspan) model of their Mars glider, Otto, in California's Red Rock Canyon last spring (below). The folding, 10-pound vehicle got its name from German aviation pioneer Otto Lilienthal.*

altitude, solar-powered Pathfinder UAV built by MacCready's company AeroVironment—would in principle be nearly capable of flying on Mars, if you could get it and its support team there.

Because of these advances in other fields, by the time NASA's planetary exploration program started to pick up again in the early 1990s, it could draw on more expertise relevant to Mars aircraft than ever before. In 1992, at the first workshop devoted to NASA's Discovery program of low-cost planetary missions, a Mars aircraft proposal was put on the table by John Langford, whose company, Aurora Flight Sciences, had developed high-altitude aircraft for NASA to use in programs much like the environmental impact study that had led Dale Reed to design the Mini-Sniffer. Langford had also managed the Daedalus project to build the human-powered aircraft that a cyclist flew 74 miles across the Sea of Crete in 1988.

As the Discovery program developed, more ideas for Mars airplanes surfaced. Larry Lemke's team at the Ames center came up with a craft that was basically a scaled-down version of the Reed Marsplane of the 1970s. Weighing about 400 pounds, it would fly for six hours or so, land, study the surface, then take off a month later for more cruising. The Ames people even had a target in mind: Gusev Crater, which, evidence suggests, may have once been a lakebed. Water inside the crater might have been warmed by a large volcano more than 100 miles to the north. Many researchers—especially at Ames, where the crater has a particularly passionate set of advocates—think Gusev could hold traces of past Martian life.

Another Ames proposal, done in cooperation with planetary scientist Mike Malin's small company (see "Getting the Picture," Aug./Sept. 1999), was MAGE, a mission that used a graceful flying wing with a pusher propeller to carry a suite of geophysical instruments over the Martian canyons. At the same time, a team involving AeroVironment, JPL, and others suggested an even simpler mission, which flew a series of small gliders rather than a single powered aircraft. "We ended up in a situation where we more or less had to choose between carrying a propulsion system and carrying a scientific payload," says Carlos Miralles of AeroVironment. Flying several vehicles instead of one added resilience. "You can tolerate failures, you can target them independently, you can cover a larger total range and get more diversity than if you are stuck with one airplane trying to fly for a long period of time," he says. Six gliders would have been popped down at different sites in Valles Marineris. Although each would have flown for at most 60 miles, together they might have provided data on the whole length of the canyon system.

Clever as they were, these ideas were slightly ahead of their time. In November 1998, after the Discovery review panels worried about the risk involved in using unproven technologies, NASA turned down both MAGE and the fleet of gliders. But the December 2003 Wright centennial, which happens to coincide with a favorable launch opportunity for reaching Mars, had already begun to generate a buzz for Mars airplanes. Both proposals had used the name Kitty Hawk—MAGE viewgraphs even had the word proudly emblazoned on the wing.

Edgar Choueiri, a plasma physicist

at Princeton University, had also noticed that the Wright anniversary coincided with a Mars launch window, and mentioned it to Norm Augustine, the former Lockheed Martin CEO who had moved to Princeton. Augustine became an enthusiastic proponent of the idea, talking it up to Dan Goldin and others in the space agency, who saw its potential as a Mars Pathfinder–like source of national excitement.

And so it was that the NASA budget came to include a bold, if modestly funded, new project: the Mars Airplane.

To the people at Ames, JPL, Langley, Dryden, Aurora, AeroVironment, and other places who had been thinking about Mars aircraft, the most striking thing about the proposal was how small the vehicle was. The Mars micromissions are parasites lifted to Earth orbit by a European Ariane 5 rocket. While going about its everyday business of launching communication satellites two at a time, the Ariane 5 has enough oomph left over to put very small payloads into highly elliptical orbits around Earth. From there, with the help of a couple of lunar swing-bys to pump up their velocity, such spacecraft can go on to Mars. French and American researchers have all sorts of tentative plans for little orbiters, penetrators, and communications relay satellites that could travel to Mars this way, all based on or carried by a standard "microspacecraft" that the Mars Airplane will be the first to use.

Because of the Ariane constraints, the aeroshell will be at most 30 inches across, meaning that the first Mars aircraft has to fit inside a container the size of a large wok. Even though the airplane will be small, weighing maybe 40 pounds, fitting it in such a tight space will require some clever origami. The designs that Langley worked on last summer had five separate folds. The outer segments of the wings fold in across the body. The vertical rudder flattens itself down onto the tailplane. And the two booms that attach the body to the tail assembly have to bend too (the booms fit on either side of the casing for the parachute, which sits in the small of the aeroshell's back).

A difficult job is made even more difficult by the Martian atmosphere.


*Otto's first flight, documented by a tail-mounted camera, lasted about 40 minutes. The first Mars Airplane flight won't be that long, and radio communication will be possible for only 20 minutes. That should still be long enough to send at least one real-time picture back to Earth.*

On Earth, aerodynamic pressure is used to bend a folded aircraft into shape. On Mars, according to AeroVironment's Miralles, who was part of a team bidding this fall to build the Mars Airplane, you have to use springs. A test model that AeroVironment developed while working on the glider project was able to spring itself into shape in only a second while falling. But springs add mass, and mass is one of the things the Mars Airplane is short of. Ease of folding was one reason why the MAGE design used a flying wing with no tail. It's unlikely that any of the teams bidding to build NASA's Marsplane will offer a flying wing, however, because there's an associated lift penalty that makes it infeasible for a very small aircraft. The ultimate solution to the unfolding problem therefore remains unclear.

Langley's official request for proposals, released in September, listed the things that the aircraft should be able to do—demonstrate powered flight and certain maneuvers, carry a small instrument package including some cameras, and so on—but didn't say how they should be done. Contractors who bid on the Mars Airplane were left to decide for themselves what shape would be best, what sort of power source to use, and other specifics.

That didn't mean, however, that the Langley team didn't have its own ideas. Engineers at the center spent most of last summer working on preliminary ideas and running tests in wind tunnels. This early work suggested that a rocket engine would be the best way to go—a hydrazine engine, already proven in spaceflight and capable of delivering two or three pounds of thrust. According to Joel Levine of Langley, the chief scientist on the program, it seems simpler and more certain than using a more complex motor and a propeller that would have to work in that terribly thin air. The incorporation of a rocket also gave one of Langley's preliminary designs a pleasingly otherworldly look—a flattened teardrop of a body with top-mounted, swept-back wings and tail booms kinked like a

NASA LANGLEY RESEARCH CENTER (5)

*NASA's Langley Research Center produced this artist's concept of the Mars Airplane (above) before testing models with raised tail surfaces in wind tunnels last summer. The vehicle's precise shape and engine are yet to be determined—contractors, not NASA, will do most of the work.*

downhill skier's knees to lift the forward-swept tail out of the rocket's hot exhaust plume. The choice between conventional and swept wings involves another tricky aerodynamic tradeoff. At low Reynolds numbers, there is a pronounced "separation bubble" between the smooth flow of air over the front of the wing and the turbulent flow at the back. At high speeds—the Mars aircraft needs to fly at about 250 mph—this bubble stretches, eventually reaching a point where the flow no longer attaches at all and the wing stalls. Sweeping the wings may help achieve the desired reattachment, as might various other tricks, such as putting knobby "turbulators" to disturb the flow on the upper surface just behind the leading edge. Split flaps on the trailing edge can also help by generating lift without reattachment. But due to its tight fit inside the aeroshell, sweeping the Mars Airplane's wings has the down side of decreasing their total area, and area is important when you need ev-

ery ounce of lift you can scrape together. "We barely have enough lift to make this go," says Juan Cruz, the project's chief engineer at Langley.

Getting enough lift will be particularly important at the beginning of the flight. After its release from the aeroshell, the airplane will be in a dive. "On Earth," says Cruz, "the same airplane would pull out of that dive in a few hundred feet. On Mars it's going to take anywhere from [2 to 5.6 miles]. We just don't have enough extra lift to bring it around." According to Miralles at AeroVironment, it's this first dive that will be the moment of truth. The longer it goes on, the faster the aircraft will be going and the closer it will come to the speed of sound (in Mars' cold, thin atmosphere, that's only 520 mph). High Mach numbers make the separation problem worse, so you want to get out of the dive as fast as possible. AeroVironment learned a few helpful tricks in this regard when designing propellers for its high-altitude UAVs, but Miralles was reluctant to talk about them this fall, while the NASA contract was still up for grabs.

Once the Mars Airplane levels out—assuming it does—low lift will still cause problems, and will make changing direction a chore. Cruz estimates the turning circle will be more than three miles in radius. So even though the aircraft will be speedy, there won't be any hot-dogging. "It will be like flying in an airliner where you sit and watch the terrain just going by," says Miralles. "You'll be closer to the terrain, but it will be the same sensation."

Leisurely though it may feel, this will be a purposeful flight. "The reason people build airplanes is not because an airplane can take you anywhere, but because an airplane can take you somewhere you want to go," Cruz says. "So we want the airplane to demonstrate that it can hold a heading and then change that direction to some pre-selected second heading. And then return to the original heading." All of this will have to be done with pre-programmed maneuvers, because Earth will be too far away to transmit advice, even at the speed of light.

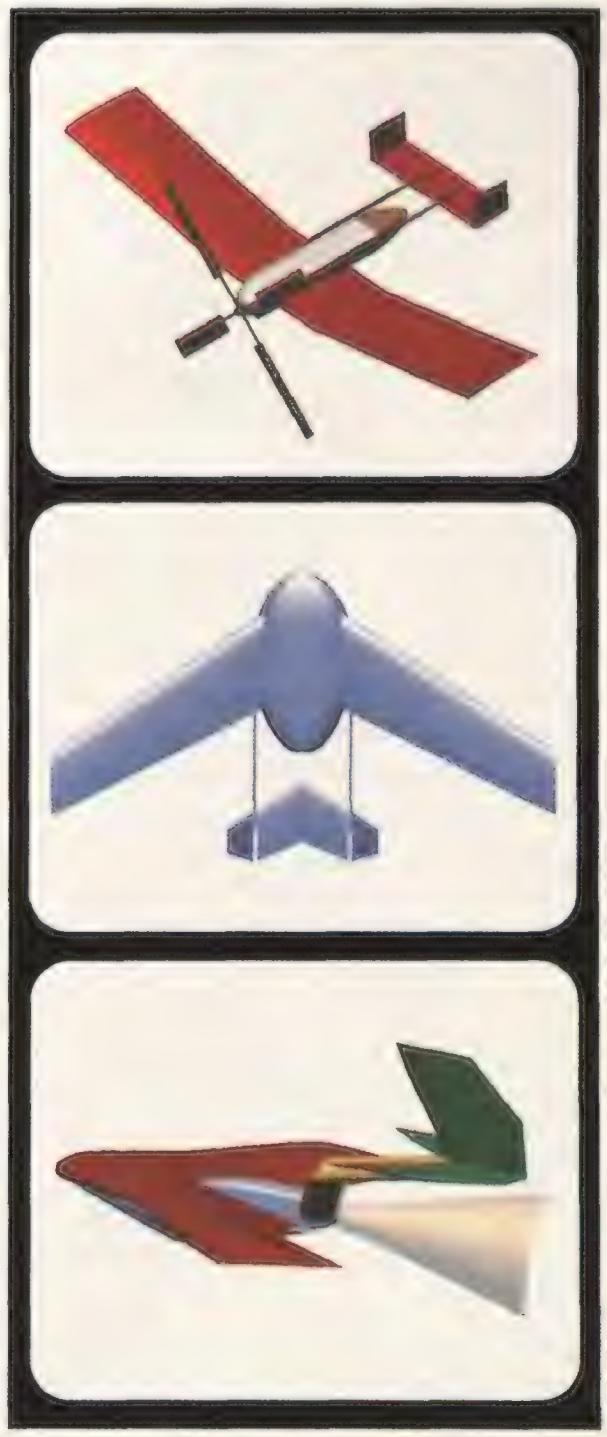
Demonstrating that the airplane can fly straight and level, turn when required, and ride out whatever turbulence may occur is the project's primary goal. But the aircraft also has a 4.5-pound science payload consisting of cameras and—if room allows—a spectrometer for assessing the mineral content of rocks and a magnetometer (one of the great surprises to come out of the current Mars Global Surveyor mission is that some regions on the planet appear to have strong magnetic fields). The cameras will be able to spot details on the surface as small as six inches across. "If Mars has rabbits, we'll see them," jokes Levine.

Unfortunately, we on Earth won't be able to watch live video of the mission because the aircraft can't carry a radio powerful enough to send back that much data. Instead, it will send signals to the spacecraft that brought it to Mars, which will store them and send them back to Earth over a period of days. This is not a perfect arrangement, not least because the carrier spacecraft will be in line-of-sight communication with the aircraft for only 20 minutes of a flight that might last longer. But it should allow some images to come back, with at least one transmitted in real time. There will be some sort of show for Earthlings after all.

Some planetary scientists look on at all this unimpressed. They worry that the Mars Airplane will cost more than currently envisioned—$60 million was one outside panel's estimate—and that what is basically a technology mission will start to eat into NASA's science budget. Some would rather have used the first micromission opportunity for a communications relay satellite that could benefit other Mars exploration spacecraft with more ambitious research agendas. And some just don't think it can be made to work. One scientist cites the Monty Python sketch about the difficulties involved in teaching sheep to fly: "The thing is, they don't so much fly as plummet."

But you can bet that if the Mars Airplane does fly, scientists will soon be queuing up to make use of its descendants' ability to explore the Martian landscape. Once landing and takeoff are mastered—this aircraft will not try either—scientific instruments could routinely be sent to many sites during the same mission, making the investigations that much more productive. And aircraft could do things that no lander (unless extremely lucky) could ever do, like sniff out molecules given off by things living on or under the surface, if they exist. Because such molecules would be local, scarce, and short-lived, says Levine, they would probably be undetectable from orbit. But a search

*Some of the preliminary designs to come out of the Langley center had the Mars Airplane's tail mounted on twin booms. The booms fit on either side of the casing for the parachute that slows the vehicle's initial descent through the atmosphere. Still undecided is whether the aircraft will be rocket- or propeller-driven, and whether its wings will be swept or straight.*



AEROVIRONMENT

by aircraft (Dale Reed's Mini-Sniffer again) could well find them. And although the existence of underground life would likely only be firmly established by drilling holes, a sniffer could at least show you where to drill.

The Mars Airplane is the first word in Mars aircraft design, not the last. "This is just the beginning of a generation of airplanes that will fly in the atmospheres of other planets," says Levine. After all, if you can fly in the near vacuum of Mars, you can fly more or less anywhere. "Over the next 30 years we're going to have many planes going to Mars, planes flying below the cloud layer on Venus to study the surface for the first time in visible wavelengths; we'll study the organic haze on Titan; we'll be sending planes to Jupiter and Saturn and looking under the clouds." He points out that a recent report from the National Research Council concluded that mobility is not just important for solar system exploration, it's essential. And mobility is just what airplanes promise.

The vehicles that make good on that promise will have all sorts of shapes and sizes. "There's not one right way to make a Mars airplane, any more than there's one right way to make an Earth airplane," says Larry Lemke of NASA's Ames center. Big sailplane-like vehicles may be good for some types of remote sensing. But if plans to manufacture rocket fuel from ingredients in the Martian atmosphere pay off, point-to-point mobility might be achieved with aircraft that use sheer speed to get around the difficulties of flying through a thin atmosphere, just as the SR-71 does on Earth. For other purposes, aerodynamically shaped dirigibles might be the way to go. The relative density of Mars' carbon dioxide atmosphere makes lighter-than-air flight attractive; so does the fact that hydrogen, a better working fluid in every way than the helium used on Earth, will not burn in carbon dioxide. Give a big arrowhead dirigible a flat top and cover it with thin-film solar cells to generate power, and it could fly around Mars forever. Someday. Perhaps.

The Mars Airplane will bequeath technology to these far-off projects, but that may not be its major contribution. The Wright brothers changed not just the way we travel around the world but also the way we see it. Today all the images we have of Mars, save for those of three rocky landing sites, come from looking down at the planet. This orbital viewpoint, while wonderfully revealing, can't help but turn Mars into a scientific specimen, a data set, a planet to study rather than a world to experience. The Mars Airplane will let us look out, not down, to distant horizons and what lies beyond them. It will let us watch our shadow moving on the rocks below as we fly through the sky. The camera in its rudder will show us the delicate banking of the aircraft's wings as it heads off in directions no one has ever followed before. Long before human pilots fly over the Red Planet, these pictures may rekindle the romance of a new world in the audience back home.

NASA AMES RESEARCH CENTER

*AeroVironment's Mars glider drop tests (above) lasted a few minutes at most. After separating from the parachute, the Mars Airplane will unfold and go into a long, nerve-racking dive before leveling out. NASA's Ames center is among the places where engineers have long thought about Mars flight. Ames even flight tested a prototype Martian glider in 1996 (right).*



For more about the Mars Airplane, visit the Web at www.airspacemag.com

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An Air & Space Magazine Guide

# The Late Show

## WHERE TO GO WHEN YOU WANT TO SEE STARS—AND PLANETS, NEBULAS, GALAXIES...

BY J. KELLY BEATTY

A balmy Friday evening in Boston offers endless possibilities for entertainment, but tonight a score of people have chosen to gather downtown, atop a dark, sparse parking garage. Suddenly the door of a windowless rooftop building cracks open, revealing the dull glow of red lights. Out pops a head. "Does anyone want to come inside?" Ron Dantowitz chirps, and a happy chorus of *yeas* greets him in reply. "That's the right answer," Dantowitz says, and so begins another night's stargazing at the Boston Museum of Science's Gilliland Observatory.

It's a scene repeated hundreds of times across North America on summer weekends and only a little less frequently in the depths of winter. To astronomers, sharing the beauty of the night sky with others is a no-brainer. Dantowitz and observing sidekick Larry Krozel are show-and-tell veterans, and on this planet-free night they manage to make even a solitary star come alive by showing off its rainbow spectrum. "Astronomy is an easy sell," Dantowitz says. "It's always great to have someone come up to the eyepiece and gasp, 'That's not real, is it?' "

Finding a skyward-pointing telescope to look through is easier than you might think. There's no need to trek off to some distant mountaintop in search of one—besides, professional observatories aren't generally open to the public. Instead, seek out a local planetarium or the astronomy department of a nearby university. Most offer public stargazing nights at least once a month. Better yet, get in touch with one of the hundreds of amateur astronomy clubs scattered around the continent. Not only will their evening "star parties" give you a satisfying eyeful, but the seasoned aficionados there can help you decide on a telescope of your own.

Star party culture is growing because, ironically, we are less and less able to appreciate the night sky. City dwellers kissed the Milky Way goodbye decades ago. Even in once-pristine rural outposts, the night's cosmic tapestry has been bleached of its splendor by the ubiquitous glare of strip malls and security lights. "Imagine children growing up without being allowed to see trees or birds," laments Daniel W. E. Green, an astronomer at the Smithsonian Center for Astrophysics in Cambridge, Massachusetts. "How is this any different from preventing our children from seeing the stars?"

### Gilliland Observatory

**Where:** Boston Museum of Science, Science Park, Boston, MA 02114

**When:** Friday nights, all year (solar viewing: Saturdays, 1:30 to 3:00 p.m.)

**What:** 7-inch and 12-inch telescopes in dome

**Cost:** free (pay parking)

**Contacts:** (617) 589-0267; http://www.mos.org/whats_happening/calendar.html


*Guide cover: Kitt Peak National Observatory. Below: A laser helps Gilliland Observatory get a bead on Jupiter.*

GUIDE COVER: AURA/NOAO/NSF; JOHN REED/COURTESY MUSEUM OF SCIENCE, BOSTON

## Astronomy in the City

Showing children—and adults—the stars is a mission many institutions have embraced. The undisputed king of the public venues is Griffith Observatory, perched on Mount Hollywood in the heart of Los Angeles. Since Griffith opened in 1935, more than five million people have looked through its venerable 12-inch-diameter Zeiss refractor. (A refractor employs lenses to focus stellar light, as opposed to mirrors or combinations of mirrors and lenses in, respectively, reflectors or catadioptric telescopes. See "Choose Your Weapon," opposite.) It's not unusual for 150 visitors to queue up for a quick peek through the scope's impressive 16-foot-long tube. Observing assistant Bob Spellman says the Zeiss is rarely turned on anything other than the moon or planets, which are peren-

*A 12-inch refractor (above) and beautiful exteriors (below) make Griffith a star in Hollywood.*

ANTHONY COOK/COURTESY GRIFFITH OBSERVATORY (2)

### Griffith Observatory

**Where:** 2800 E. Observatory Rd., Los Angeles, CA 90027

**When:** every night (no Mondays in winter), all year

**What:** 12-inch telescope in dome

**Cost:** free (pay parking)

**Contacts:** (323) 664-1191; http://www.griffithobs.org/Generalinfo.html


nial crowd favorites. After getting moonstruck, you can take in the breathtaking cityscape below or wander through Griffith's astronomical displays. Take a seat under the 75-foot planetarium dome and you'll be transported to a Los Angeles that hasn't existed for a century, with brilliant stars strewn across a pitch-black plaster sky.

Another facility offering full-service astronomy is the Boston Museum of Science and Charles Hayden Planetarium. The recently renovated planetarium seats 240, and its daily shows cost $7.50 (kids: $5.50). In 1995, benefactor Wendy Kistler funded a new public observatory to honor her father-in-law, an avid skygazer. Under the dome atop the museum's parking garage are "Abbott" and "Costello," a sleek seven-inch refractor and a stubby 12-inch catadioptric scope. But the real star is the computerized $16,000 mount that moves them both. Its sophisticated electronics can track almost anything—even fast-moving satellites, as evidenced by Dantowitz's remarkably detailed snapshots of Mir, the space shuttle, and other spacecraft cruising hundreds of miles over Boston. Gilliland's smallish dome gives the Friday night sessions an intimate one-on-oneness, and guests often linger for extra views through the eyepiece. Sun watching

## Choose Your Weapon

The types and sizes of telescopes you're likely to encounter at a public outing are as varied as their handlers. Generally, though, there are three main styles: reflectors, which employ curved mirrors to focus light into the eyepiece; catadioptrics, which use combinations of mirrors and lenses; and refractors, which rely exclusively on lenses. These telescopes can cost anywhere from $250 to $20,000 or more—much more in the case of professional observatories. They usually sit on beefy tripods or piers that minimize vibration and allow for the steady operation of motorized mounts, which track objects as they move across the sky—or, more precisely, as Earth's rotation gives that impression. (If, for example, you switch the motor drive off while viewing Saturn at high magnification, the ringed planet will drift out of view in a matter of seconds.)

The best views most often come from telescopes with a large aperture—that is, the diameter of the lens or mirror used to collect and concentrate the heavenly light. In terms of desirable attributes, "power," or magnification, ranks a distant second. Unfortunately, the scopes sold most often in retail stores have apertures of under four inches and generally very poor optics, and they tend to emphasize magnification over light-gathering capability. But a well-equipped amateur astronomer might pack a refractor of five or more inches or a reflector with an eight- to 20-inch mirror costing thousands of dollars. At a professional observatory you might be treated to views through scopes with apertures of 30 inches and up.

*Saturn as it might appear through a high-quality eight- to 12-inch telescope.*

# Astronomy Has Its Day

The San Francisco area has long been in the forefront of bringing astronomy to the people, so it's no surprise that a nationwide celebration of astronomy had its roots there. Doug Berger and fellow members of the Astronomical Association of Northern California launched Astronomy Day in 1973, and since then the spring ritual has spread to hundreds of locations in North America and more than a dozen countries. Astronomy Day is usually celebrated on the Saturday closest to the first-quarter moon between mid-April and mid-May. Next year's date is April 8, though some groups will plan activities throughout the prior week or on adjacent weekends.

CAMERON DAVIDSON

## Bishop Planetarium

**Where:** 201 10th Street West, Bradenton, FL 34205

**When:** Friday nights, all year (solar viewing: Saturdays, 11:30 a.m.–1:00 p.m.)

**What:** lecture, 8-inch and 6-inch telescopes in dome

**Cost:** Adults, $3.00; kids, $1.50 (pay parking)

**Contacts:** (941) 746-4132; http://www.sfmbp.com/observatory/Observatory.htm


UNIVERSITY OF VIRGINIA DEPARTMENT OF ASTRONOMY

*The 24-inch refractor at Leander McCormick is one of the world's largest (above and bottom left).*

## Leander McCormick and Fan Mountain observatories

**Where:** University of Virginia, Charlottesville

**When:** 1st and 3rd Friday nights, all year (groups: 2nd and 4th Fridays)

**What:** lecture, tour, viewing with 26-inch telescope in dome

**Cost:** free (limited free parking)

**Contacts:** (804) 924-7494; http://www.astro.virginia.edu/pubnite


sessions, during which the telescopes are fitted with solar filters, are held Saturdays from 11:30 a.m. to 2:30 p.m.

Such pairings of planetariums and public stargazing are common across North America. Usually a multimedia "What's up?" presentation inside precedes the telescope time under the stars. At Bishop Planetarium, part of the South Florida Museum in Bradenton, the package deal costs just $3 (kids:

$1.50), or you can head right for the telescopes for $1. Director George Fleenor says the evening program is more popular in cooler weather, when he can count on seeing a few "regulars" visiting month after month. Amateur astronomers from the Bradenton area help run the observatory's eight- and six-inch refractors on Friday and Saturday evenings. The scopes are trained on the sun each Saturday from 11:30 a.m. to 1:00 p.m. And when the clouds roll in, you can always check out Snooty and Mo at the museum's Parker Manatee Aquarium.

Especially in a city setting, big telescopes are big draws. For example, in Charlottesville, Virginia, the University of Virginia's Leander McCormick Observatory boasts a telescope with a 26-inch lens—one of the world's 10 largest refractors. The observatory's public viewings routinely draw capacity crowds of 300. "We are overwhelmed," says university astronomer Philip Ianna, who has recently doubled the number of observing nights and enlisted volunteers from the Charlottesville Astronomical Society. The public now comes on the first and third Fridays each month, with the second and fourth Fridays reserved for prearranged groups. McCormick's ivy-covered dome is steeped in history: Thomas Jefferson had included an observatory in his plans for the university (on Mount Jefferson, at the campus' edge), though it was not completed until 1885. By tradition, all members of the astronomy department—even tenured theoreticians—assist with the public programs.

Another historic, public-friendly facility can be found atop Mars Hill in Flagstaff, Arizona. That's where Percival Lowell—wealthy Bostonian, self-taught astronomer, and avowed Martian chaser—built a world-class observing complex in the 1880s. In recent years Lowell Observatory has enjoyed a resurgence of professional prestige and public interest, which culminated in 1994 with a centennial celebration and the unveiling of a new visitors' center. Today you can follow in Lowell's storied footsteps at least one night per week in winter, up to six in summer. For a $3.50 admission fee (kids: $1.50), you'll get a preview of the current sky sights, followed by observing with either a 24-

## Lowell Observatory

**Where:** 1400 W. Mars Hill Rd., Flagstaff, AZ 86001

**When:** Fridays, Saturdays, and other days (schedule varies seasonally), all year

**What:** lecture, 16-inch or 24-inch telescope in dome

**Cost:** Adults, $3.50; kids, $1.75 (free parking)

**Contacts:** (520) 774-3358; http://www.lowell.edu/visitors/Visit/Eveningprog.html

*The planet Mars as it might appear through a high-quality eight- to 12-inch telescope.*


GENE BLAZHO/COURTESY LOWELL OBSERVATORY

*At Lowell Observatory, budding astronomers can view planets through the telescope that Percival Lowell used while hunting for Martian life.*

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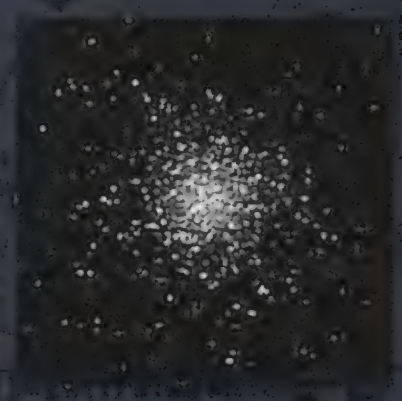
# The View Through a Telescope

Planets and deep-space objects photographed by the Hubble Space Telescope and countless ground-based observatories reveal a wealth of detail and color. However, that quality can only be attained by long exposures—often several hours—through carefully balanced, motor-driven telescopes using digital cameras or traditional film. Visual observation of the same objects won't duplicate this quality, but few astronomers—amateur or professional—come away disappointed from a clear night out with their telescopes. Saturn, Jupiter, and Mars change constantly, and diamond-studded star clusters and distant nebulas prove to be endlessly challenging targets. With practice, and under good observing conditions, more and more detail will emerge through the most modest backyard telescope.

Certain planets and deep-space objects are among astronomers' favorite targets. Among them are M81, an oval galaxy about 11 million light-years distant (top); the always-stunning Jupiter (center), and M13, a globular star cluster 21,000 light years away (bottom). These images were taken and digitally altered by astrophotographers Todd Gross of Boston and Maurizio Di Sciullo of Coconut Creek, Florida, to approximate views through eight- to 12-inch telescopes.

TODD GROSS (2)

MAURIZIO DI SCIULLO

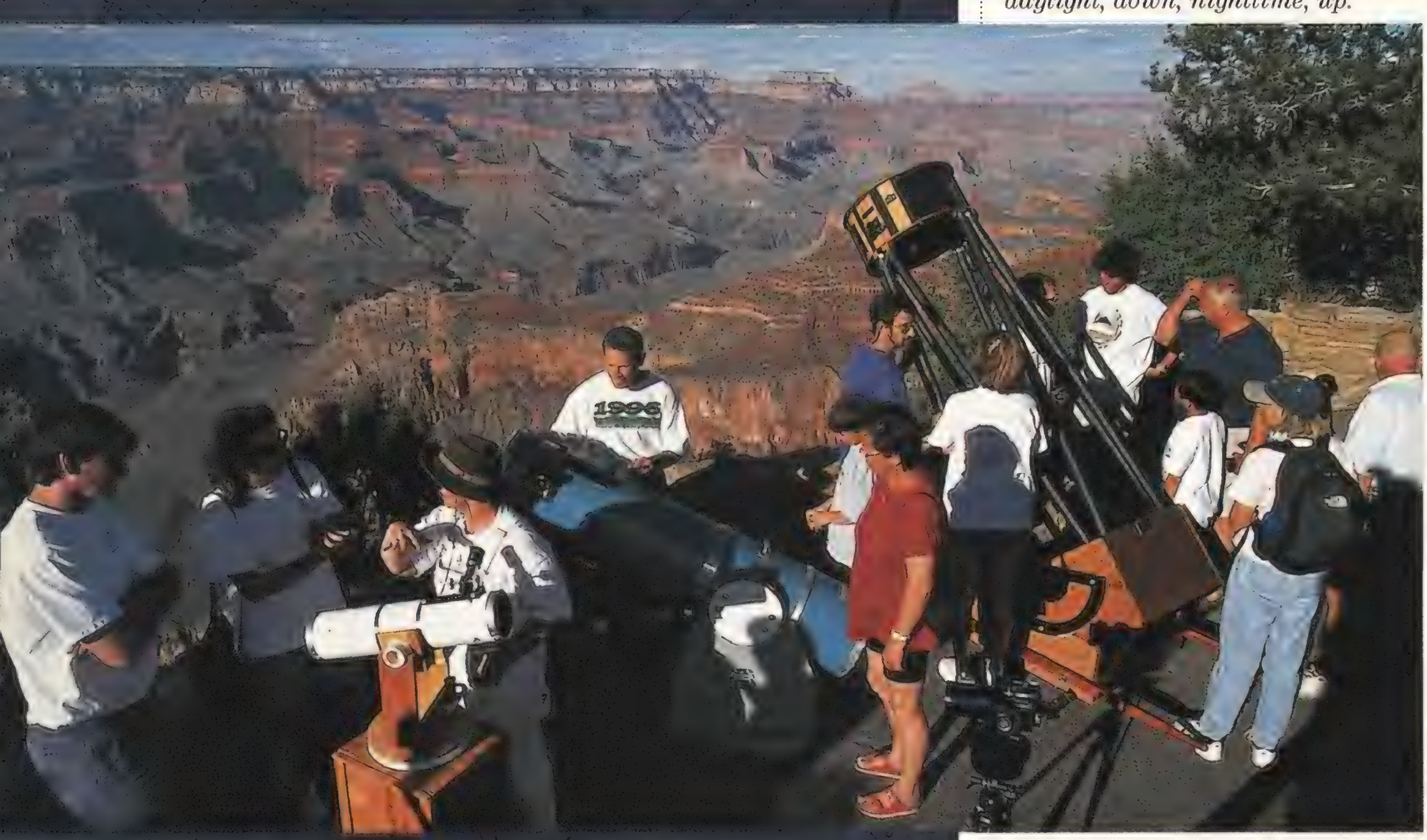


inch refractor or a 16-inch compound reflector. Daytime visitors can enjoy a quick peek at the sun (daily at 12:30 p.m.) or stroll down the Pluto Walk to see the 13-inch photographic telescope that Clyde Tombaugh used in 1930 to discover distant Pluto.

If time permits, head 230 miles south to Tucson, the current mecca of American astronomy. There you'll find the headquarters of the National Optical Astronomy Observatories and the University of Arizona's Flandrau Planetarium and Steward Observatory. An hour's drive to the southwest brings you to the 6,875-foot summit of Kitt Peak and face to face with the most impressive collection of professional telescopes in North America.

In the past, NOAO offered public viewing on Kitt Peak only once a month, in a dome adjacent to its visitors' center. But a new, expanded program lets you reserve the night you want in advance, and it's limited to just 20 participants. After arriving at the summit

*Which view at the Grand Canyon Star Party is better? It's easy: daylight, down; nighttime, up.*



ERIC SANDER

AURA/NOAO/NSF (2)

*Kitt Peak's two-meter telescope (foreground and below) waits for the stars as astronomers at the McMath-Pierce Solar Facility study our own, the sun.*

## National Optical Astronomy Observatories

**Where:** Kitt Peak National Observatory (P. O. Box 26732, Tucson, AZ 85726)

**When:** every night, all year (reservations required)

**What:** lecture, 16-inch telescope in dome

**Cost:** Adults, $35; kids, $25 (free parking)

**Contacts:** (520) 318-8726; http://www.noao.edu/noao/pio/pop/pop.html


before sunset, pre-registered guests are offered a light meal and an orientation lecture. The staff provides top-quality binoculars for everyone, and there's plenty of time for eyeballing the heavens through a 16-inch compound reflector. Cost is the only catch: $35 for adults, $25 for kids, or $100 for a family of four. For $250 each, two diehard observers can take over the telescope for an entire night, recording their finds with state-of-the-art elec-

tronic cameras and even dining with visiting astronomers (room and board cost an additional $55 per person).

### Off the Beaten Track

Astronomical opportunities are not always as obvious as a Griffith or Kitt Peak observatory. In fact, the very best places to cruise the cosmos are remote locations with sparse populations. One such gem is Goldendale Observatory in south-central Washington. In the early 1970s, four Vancouver men built a 24-inch reflector from scratch and donated it to the small city of Goldendale. Washington's State Parks and Recreation Commission took over the facility in 1980, and today it exists solely for public use. The big scope is augmented by more than a dozen portable

## Goldendale Observatory

**Where:** 1602 Observatory Dr., Goldendale, WA 98620

**When:** Wednesday–Sunday (April–September), Saturdays (October–March)

**What**: lecture, 24-inch and 8-inch telescopes in domes

**Cost:** free (free parking)

**Contacts:** (509) 773-3141; http://www.parks.wa.gov/goldendl.htm


and permanently mounted companions of various sizes. Stephen Stout has been the sole staffer there for nearly 19 years. He provides lectures and telescopic viewing five nights a week from April through September and only on Saturdays during other months. Despite being hard to find, Goldendale hosts up to 200 visitors a night and 30,000 to 40,000 a year, many of them children from the region's schools. Continued success has Stout dreaming of a $3 million renovation, but putting eyeball to eyepiece will always be part of the Goldendale experience. "I never want to take away the direct viewing through the telescope," he says.

Two other well-hidden retreats are found in the Southwest. Eleven years ago Philip Mahon took a huge gamble: He bought 195 acres of remote, forest-rimmed land in New Mexico's Sangre de Cristo Mountains, built an observing compound with seven cozy cottages, and held his breath. Today the Star Hill Inn, which he operates with wife Rae Ann Kumelos-Mahon, is thriving. Each year, the inn hosts roughly 800 visitors, who come from as far away as Singapore to revel in the dark skies. One couple liked the place so much that they recently held their wedding

ERIC SANDER (2)

*Telescopes of all shapes and sizes crowd the Skywatcher's Inn (above), where a model of the solar system helps visitors keep things in perspective (below).*

### Skywatcher's Inn

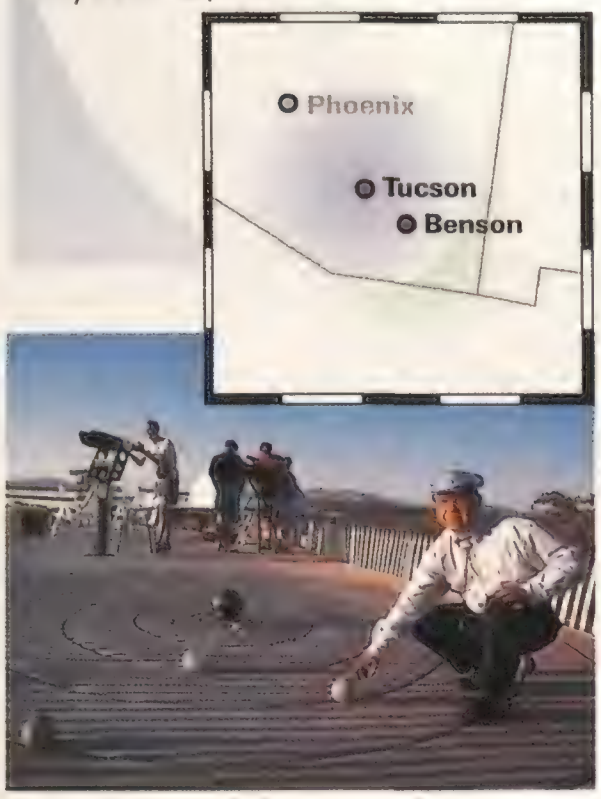
**Where:** Benson, AZ (mail: 5655 N. Via Umbrosa, Tucson, AZ 85750)

**When:** every night, all year (reservations required)

**What:** Various scopes up to 20-inch aperture

**Cost:** $75-160/night for lodging (telescope rental extra)

**Contacts:** (520) 615-3886; http://www.communiverse.com/skywatcher/




there. An overnight stay costs as little as $80 for a single or $90 for a double, though there's a two-night minimum. No meals are served, but all the cottages are equipped with kitchens. "That was one of my best decisions," Mahon says. "Observers who stay up all night don't want someone telling them when to eat." Some guests bring their own gear, but most choose from a small arsenal of rental telescopes.

Another good choice for an astronomical sleepover is Skywatcher's Inn in Benson, Arizona, about 50 miles southeast of Tucson. Eduardo Vega had already set up his Vega-Bray Observatory when his wife Patricia decided to add the inn a few years ago. Guests share common living, dining, and entertainment rooms, along with three kitchen units. Rates start at $89 per room, but you might want to splurge. As recent guest Ed Ting notes, "I expected a simple rustic retreat. Boy, was I wrong! Within minutes I found myself happily installed in the Egyptian room, complete with marble jacuzzi, satellite TV, and walk-in marble shower." Vega did not skimp on the astronomical amenities either. Vega-Bray offers a computer-controlled 20-inch telescope, seven others with apertures from six to 14 inches, a small planetarium, a radio telescope, and a photographic darkroom. Equipment fees range from $55 for the smaller scopes

### Star Hill Inn

**Where:** PO Box 1A, Sapello, NM 87745

**When:** Every night, all year (reservations required)

**What:** Various scopes up to 22-inch aperture

**Cost:** $80-120/night for lodging (telescope rental extra)

**Contacts:** (505) 425-5605; http://www.starhillinn.com


to $150 for an entire night with the 20-inch and the services of an imaging expert or professional astronomer. However, Skywatchers Inn, like Star Hill, is not just for the high-end astrophile. Both offer guided sky tours for novice observers and families.

## Observing Power to the People

As appealing as such retreats might seem, most would-be observers are stuck in the city and forced to make out a few stars through bright skyglow. But urban dwellers sometimes have the advantage of enthusiastic amateur astronomers who set up telescopes in prominent downtown areas. The most famous of these roving bands, the San Francisco Sidewalk Astronomers, made their debut in 1967. Legend has it that two prepubescent pupils of telescope-making guru John Dobson were denied membership in the local astronomy club. In protest, Dobson helped Bruce Sams and Jeff Roloff set up their homemade scopes on the corner of Jackson and Broderick streets. Thirty-two years later both the sidewalkers and Dobson (now 87) are still going strong. You can find them on the Friday or Saturday night nearest the first-quarter moon. These days they

usually hang out at the corners of 24th and Noe, 24th and Sanchez, or 9th and Irving. "Our only reason for being is to show the sky to people," Dobson says.

Another such group, the Toronto Sidewalk Astronomers, can be found encamped along Lake Ontario on many Monday nights. Chris Burns admits that he and five friends like to go out and "bug people to look through our telescopes." The Toronto group, which started in 1992, tries to have at least three members out along the shore on any given night. Two of them operate the telescopes and one serves as "designated theorist" to answer questions. As befits such informal gatherings, the scopes have comical names like Rocky and Bullwinkle. Most of TSA's members are graduate students at the University of Toronto, whose astronomy department offers free public stargazing on the first and third Thursdays of each month. The staff uses an eight-inch refractor atop Burton Tower on the St. George campus.

Sidewalk astronomers love to treat unsuspecting passersby to views of the moon and planets. "We pick mostly beaches," says Burns, "because they're prime dog walking spots." Barry Hirrell, one of the San Francisco group's members, adds, "We put our telescopes in places that you'd most likely kick them over." But tracking down a sidewalk troupe's whereabouts can be tricky—call ahead before setting out. The same advice holds for rooting out observing activities in any locality, which often go unadvertised, and for this task Internet searches can prove invaluable. One online directory, maintained by my employer, *Sky & Telescope* magazine, boasts listings for more than 2,000 planetariums, observatories, and astronomy clubs throughout North America and Europe (www.skypub.com/resources/directory/directory.html).

Wherever you manage to find one, a star party will inspire you to appreciate the night sky in a new way. Dobson's philosophy is simple: "We amateurs have a responsibility to show others what our universe looks like through a telescope." And while the legions of amateurs are far short of satisfying his mantra—"A telescope in every driveway, on every sidewalk"—they stand ready to offer satisfying glimpses of the cosmic beyond.

### Toronto Sidewalk Astronomers

**Where:** Ashbridge's Bay Park, Lakeshore Blvd. East at Woodbine, Toronto, ON

**When:** Monday and other nights, all year

**What:** Various telescopes up to 12-inch aperture

**Cost:** free (street parking as available)

**Contacts:** (416) 978-3148; http://www.astro.utoronto.ca/~burns/TSA.html


### San Francisco Sidewalk Astronomers

**Where:** 24th and Noe, and elsewhere in San Francisco, CA

**When:** Saturday nights near first-quarter moon (schedule varies), all year

**What:** various telescopes to 12-inch aperture

**Cost:** free (street parking as available)

**Contacts:** (415) 289-2007; http://members.aol.com/raycash/sidewalk.htm


## Other Observatories with Public Programs

**United States Naval Observatory**
USNO, 3450 Massachusetts Ave. NW,

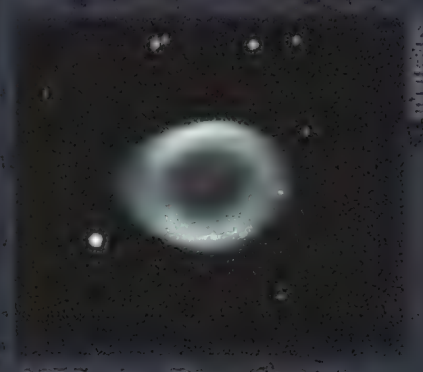
Washington, DC 20392-5420; (202) 762-1437; http://www.usno.navy.mil/

**Fremont Peak Observatory**
Fremont Peak State Park, California
FPOA, PO Box 787, San Juan Bautista, CA 95045; (408) 623-2465; http://atronomy-mall.com/fpoa/

**Menke Observatory**
Guy Worthey, Dept. of Physics & Astronomy, St. Ambrose University, Davenport, IA 52803; (319) 333-6141; http://astro.sau.edu/~astro/html/Public.html

**Salt Lake Astronomical Society**
PO Box 26114, Salt Lake City, UT 84126; (801) 531-4952; http://www.utah.edu/Planetarium/SLAS.html.

**New Mexico Skies Guest Observatory**
Mayhill, New Mexico
PO Box 559, Cloudcroft, NM 88317; (505) 687-2429; http://www.nmskies.com



*M57, the Ring Nebula, as it might appear in an eight- to 12-inch scope.*

UPDATE

# The NeXt

Boeing X-32

Lockheed Martin X-35

# Generation

## What to expect from the latest flock of X-planes.

by George C. Larson *Illustrations by Paul DiMare*

New research aircraft are being announced at a rate that hasn't been seen since the post-World War II period, when the X-1 became the first in a distinguished lineage of craft designed predominantly for a single purpose: exploration of high-speed aerodynamics. During the late 1940s and throughout the 1950s, new shapes featuring swept wings, variable wings, tiny wings, and nearly no wings at all flew at speeds ranging from Mach 1 to more than Mach 6 and ventured out into the fringes of space (see "The X-Planes," Oct./Nov. 1993). Now a new generation of vehicles will take it from there.

While the majority of the first X-aircraft carried pilots, most of the next generation will be commanded remotely and flown by a combination of ground controllers, onboard computers, and autopilots. Aircraft with a hero strapped inside may have more sex appeal, but they are also heavier, more complicated, and more expensive. The highly focused research of the new craft, most of which are designed to prove various concepts, does not depend on onboard humans. And humans are increasingly unnecessary as more powerful avionics, navigation systems, and flight control computers are being matched up with lighter and more durable materials for reentry heat shields, as


Boeing-NASA X-36

well as radical new methods for maneuvering without the use of traditional control surfaces such as elevators, ailerons, and rudders. This trend is being echoed in military aircraft design, which is also increasingly turning to remotely piloted vehicles.

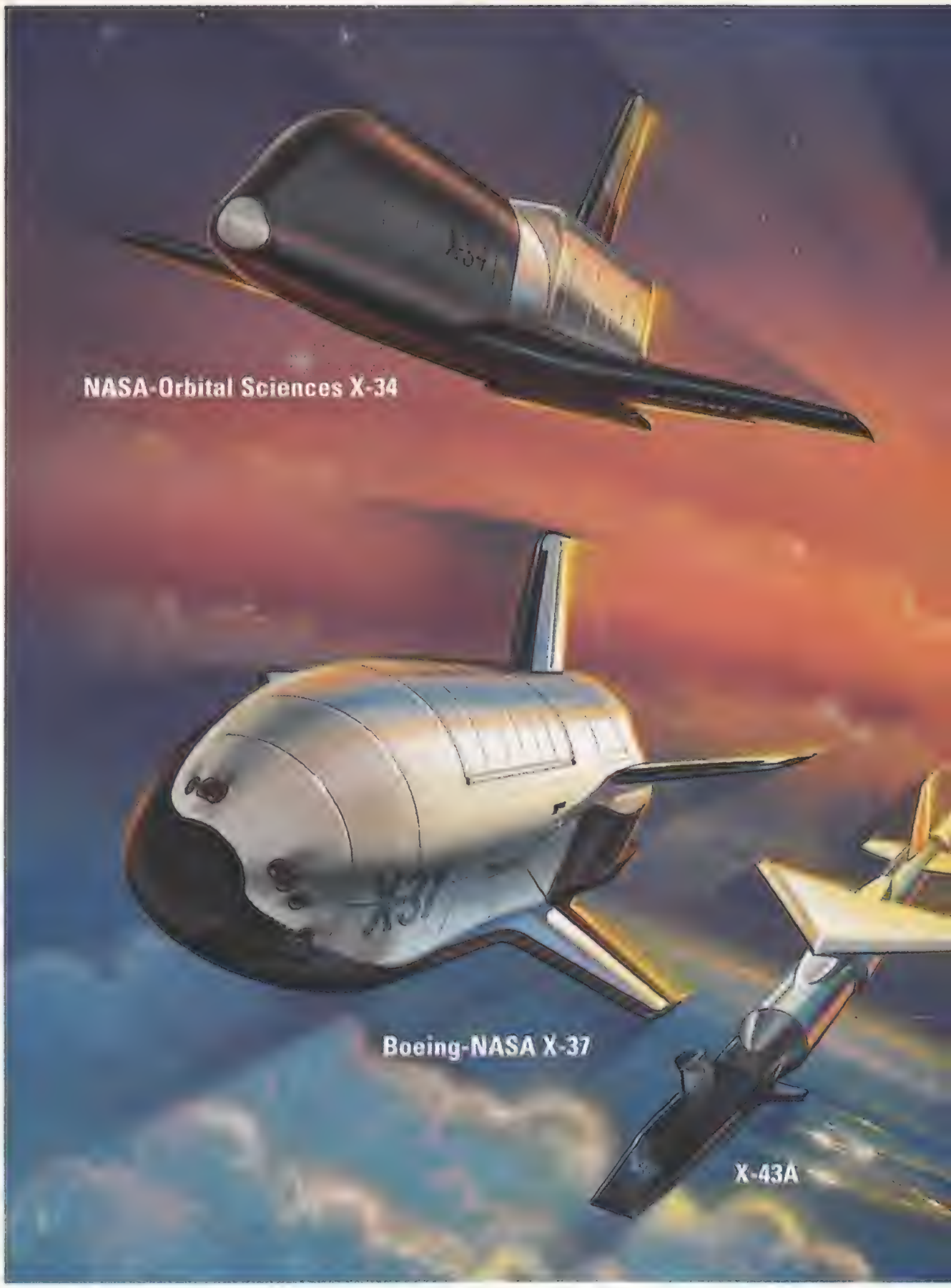
Among the new class, there are two exceptions to the trend. One is the **Boeing X-32**, a prototype for a future airplane called the Joint Strike Fighter. As the word "joint" suggests, this airplane is to be produced in different versions for different customers. There's a conventional version for the U.S. Air Force, a carrier version for the U.S. Navy, and a vertical-takeoff version for the U.S. Marine Corps and the United Kingdom's Royal Navy. Because these airplanes are intended to be relatively inexpensive to build and maintain, 90 percent of their parts will be common to all three versions. Beneath its nose, Boeing's prototype has a distinctive intake scoop that's vaguely reminiscent of the LTV A-7D Corsair II.

The other new X-plane that carries a real, live pilot is the **Lockheed Martin X-35**, which is competing with the X-32 for the Joint Strike Fighter contract. It has a trapezoidal wing instead of the Boeing design's delta shape, and distinctive twin intakes at the wing roots.

The **Boeing-NASA X-36** is unique in being a remotely piloted research prototype for what could ultimately become a piloted fighter. The 28-percent-scale craft is powered by a Williams jet engine and is the only member of the new generation that has absolutely no vertical surfaces. The design is intended to prove that a shape can be both stealthy and highly agile. A video camera in the nose provides the pilot with a view from what would be the cockpit, and the airplane is flown from a station on the ground. The X-36 has completed its research flying and is currently being stored at NASA's Dryden Flight Research Center in California.

The X-32, X-35, and X-36 are all capable of supersonic speeds and intended for atmospheric flight. They are outnumbered by new X-craft designed to fly higher, faster, and out to Earth orbit and back.

The **Lockheed Martin-NASA X-33** is a scaled-down demonstrator for a future Reusable Launch Vehicle, a craft aimed at reducing the cost to place payloads




in orbit (see "Infrequent Fliers," Aug./Sept. 1999). It combines a wingless lifting body shape with a new type of engine called a linear aerospike, which is like a conventional rocket nozzle turned inside out; combustion takes place on its external surface instead of inside a bell-shaped nozzle. The X-33 takes off vertically, climbs to an altitude of 60 miles at speeds up to Mach 15, and lands on a runway like an airplane.

As an interim step, the **NASA-Orbital Sciences X-34** will test various materials and concepts up to speeds of Mach 8 and altitudes of 250,000 feet. Powered by a rocket engine using kerosene and liquid oxygen, the X-34 will be dropped from a Lockheed L-1011 airliner that Orbital Sciences has transformed into a launcher for its Pegasus winged boosters (to which the X-34 bears a slight resemblance). It will return to land on a conventional runway and will be used to research techniques to reduce the time between flights of reusable launch vehicles.


A Pegasus booster will also be used as a carrier for the unusual **X-43A** series of NASA research vehicles, built by MicroCraft under a program called Hyper-X, for "hypersonic aerodynamics research." A B-52 will carry the booster-X-43A combination to launch altitude, then release it. The Pegasus will accelerate the X-43A to Mach 7 and Mach 10 for experiments in aerodynamics and scramjet propulsion ("scramjet" is shorthand for "supersonic combustion ramjet"). At the end of each flight, the craft will crash into the Pacific Ocean.

Another series of experimental flights will culminate in orbital research. The **NASA X-38** is a craft designed to prove that a vehicle docked with the international space station can be used by the crew to return to Earth if necessary (see "Lifeboat," Aug./Sept. 1998). The X-38 is based on a wingless lifting body research vehicle, the X-24, which was conceived in the mid-1960s. Designed for a one-way trip, the X-38, which began drop tests last spring, will make its final test flights from orbit and land at very low speeds by deploying a huge parafoil, which has already proved successful in tests.

Its designation suggests that the **Boeing-NASA X-37** is the X-38's predecessor, but the craft actually came into being only last August. Both it and the **X-40A**, which has already been dropped from a helicopter to glide to a successful autonomous runway landing, resemble scaled-down space shuttles. The two craft are aimed at developing technologies for an unpiloted orbiter that would be able to fly in space and return to land on its own. But the X-37, larger and more complex than the unpowered X-40A, has a rocket engine that uses jet fuel and hydrogen peroxide. Boeing says the X-37 could lead to a commercial launch vehicle that provides cheaper access to orbit.

The X-31, a delta-wing airplane with thrust-deflecting paddles and the ability to fly at extreme attitudes with its wings fully stalled (see "Stall Tactics," Apr./May 1991), was the last active member of the previous wave of test aircraft. If it gets further funding from the three partners backing it—Germany, Sweden, and the United States—it will embark on a second career. With most of its vertical fin and rudder removed, it will be used in a program called VECTOR, for Vectoring Extremely short takeoff and landing Control, and Tailless Operations Research, which will focus on aircraft using vectored thrust aboard carriers.

Expect the surge of new designs to continue. Other numbered slots for X-craft are reportedly allocated, and there's even a conceptual drawing of an X-44 in circulation (it's said to resemble a tail-less F-22).

The first generation of research craft were designed solely to conduct research in aerodynamics. The latest generation are combining high-speed research in aerodynamics and spaceflight with exploration of a realm that research aircraft have never probed before: economics. Reduced size and weight, smart avionics that replace the pilot, new low-cost materials that resist high-Mach heat—all signs point to a future in which performance remains the foremost goal, but affordability runs a close second.

For more about the new X-planes, visit the Web at www.airspacemag.com


PROPERTY, U.S. GOVERNMENT
EMERGENCY
DRINKING WATE

REED RAHN

# GEAR HEADS

## Collectors of survival equipment have a craving for flight helmets, life vests, ejection seats—even shark repellant.

by Tom Harpole
*Illustrations by Harry Whitver*

Lee Patterson pulls up to the main entrance at Luke Air Force Base, near Phoenix, and flashes his police detective's badge. The enlisted man at the gate takes in his spotless white pickup, glances at the gold shield, and waves him through. Obviously, the guard doesn't know him. But when Patterson walks into the aircrew life support facility, the ribbing starts.

"Oh man, it's Lee, hide everything that ain't bolted down," Staff Sergeant Jonathan Redfern says.

"Most places I can portray myself as semi-normal. Here that doesn't work," Patterson says.

Patterson collects aviation life support equipment—everything pilots use when they punch out, including ejection seats. He has been collecting since age 12; later, he bought a parachute, learned how to pack it, and had it modified so that he could jump with it as soon as he was 16 years old. Now 51, he has amassed a collection of gear that includes 123 complete sets of aircrew ensembles, each one consisting of every piece of equipment issued to a pilot or crew member of a specific aircraft from the helmet down, including oxygen mask, flightsuit, G-suit, life vests, boots, and gloves.

Even having the complete set of gear is not enough for Patterson: The dates on the equipment must match. A post-1974 F-4 pilot's ensemble, for instance, isn't correct unless its survival knife has a metal guard on the tip of its sheath. "If you have a 1969 F-4 ensemble and the knife sheath has a metal tip, well, you have a problem," Patterson explains as he slides a survival knife in and out of its sheath. "I am not obsessed," he says like a mantra, "it's either correct or it isn't. I'm fascinated with life support equipment. I like finding and seeing things that other people miss, and I love symmetry."

One can imagine, then, what it meant to him to look up and see a perfectly symmetrical parachute canopy over his head as it lowered him, exhilarated, to the ground on the first of the 52 jumps he made between 1964 and 1972. "But I have never lost my fascination with survival equipment and parachutes—lives hanging under string and silk"—Patterson interrupts himself: "Actually, silk parachutes were phased out in the late '40s," he says, then continues. "When I come home from work, where I investigate death, working on a collection of life-saving stuff keeps me from bringing my day job home."

Patterson is one of thousands of collectors worldwide who acquire and squirrel away pieces of military aviation history. As with many people who own surplus military equipment, he can't always admit how he acquired certain pieces in his collection. When asked where he finds all his gear, he deflects the question: "It used to surprise even me, the stuff that you'd see for sale at the DRMOs," Patterson says. The DRMOs, Defense Reutilization Ma-

*If it's ejectable, Lee Patterson has it. In his house, space—on the shelf or floor—seldom survives for long.*


*The stout, Vietnam-era HGU-34/P could be a pain in the neck on a long mission. Today's lighter helmets have separate visors.*

terials Organization, are the military equivalent of the world's biggest garage sales. However, Patterson pieced most of his collection together by browsing through surplus stores, garage sales, auctions, and gun shows, where he barters, trades, and reluctantly shells out cash. He also picks up bits and pieces retired by the Luke life support facility, which he visits every few weeks.

A cop in the Colombo mold, he's a keen observer of people who doesn't attract attention to himself. "Never wear nice clothes when you're negotiating the price on something," he laughs. "I'll be traveling on business and skip lunch to go find an old surplus store and stop and change into a sort of costume so the guy won't think I've got money. I usually get dirty anyway, if the owner will let me go scrounge in his basement."

Patterson explains this in front of Redfern and his colleague, Staff Sergeant Akoni Mirafuentes. "They've seen this behavior," he says.

"We know how you've pilfered, uh, I mean collected all that stuff," Redfern says.

"He's just trying to make it sound like he came by the collection more or less honestly," Miraflores adds.

"Actually," Redfern says, "we've got a Lee box that's one step below the trash can."

Patterson earns any collectible "scraps" the Air Force discards. He loans the Luke life support facility various parts of his collection so that the aircrews can see the evolution of the equipment they use. He rotates his displays of mannequins dressed in full ensembles so that aircrews can make comparisons to current equipment. He has also built miniature dioramas that depict various ways to use a parachute for survival and loaned them to the facility. More importantly, several years ago, when the Air Force was conducting MIA searches in Southeast Asia, the investigators contacted him to find out what type of parachute hardware Vietnam-era pilots used so that if they found any buckles or other harness parts at wreck sites, they would know the pilot had gone down with the aircraft. Patterson's collection represents a 55-year chronology of ejection and survival gear for pilots. It is more comprehensive than anything owned by a military aviation museum, and within it there are many histories.

Patterson's 150-some helmets, for example, chronicle the evolution of head protection from the soft leather, fleece-lined gear worn in open-cockpit aircraft to hard leather helmets (similar to what early football players used) to current-issue helmets with boom, lip, or throat microphones, amplifiers, earphones, and even night-vision goggles. There are stories in even the smallest details, such as how chin straps, oxygen masks, and a helmet's inner suspension systems evolved.

The faster and higher jets flew, the more elaborate helmets became, including pressurized models for the jet- and rocket-powered X-planes that started flying in the 1940s. Patterson's collection, arrayed along several hundred feet of shelving in his basement, shows the basic shells and the plethora of equipment that were added to cover the human head as military aviation became more demanding, and surviving a mishap in an aircraft traveling at supersonic speeds posed unprecedented design challenges. Patterson has helmets with reflective tape (for night water rescues) and gold visors meant to reflect the flash of nuclear weapons before missiles became the delivery system of choice.

"In my collection, you can see how some helmet technology went full circle," Patterson points out. "Visors, which went from external track mounts to internal encapsulation to protect the plastic, are gone. Current-issue visors are back to technology of the '40s and '50s. They are really just fancy goggles held in place with elastic and nylon webbing."

Patterson built his collection piece by piece after he researched and began looking for thousands of small, seemingly unrelated parts—buckles, chin straps, flashlights, compasses, waterproof maps—to complete his ensembles, some of which comprise hundreds of elements, including Martin Baker ejection seats, made up of 1,300 parts. He holds a small survival tin containing comestibles and cigarettes, which he needed to complete a World War II ensemble. "Seventy five bucks," Patterson says. "A few years ago this stuff was just thrown out. But now there are collectors everywhere and the prices are ridiculous."

That there are thousands of collectors of aviation artifacts worldwide attests to two facts, according to R. Chad LeBeau, proprietor of Aviation Artifacts, Inc.: People are infatuated with airplanes, and they can't afford them. LeBeau can talk for days about collectors, warbird parts, and his experiences as perhaps the biggest private collector and dealer of warbird paraphernalia in the United States.

"Museums want the big stuff, planes and engines. My customers want their own planes too, but they can't have them, so they decide to collect the stuff that the pilots touched," says LeBeau. "They're treasure hunters who start collecting stuff they can afford and it gets to be a compulsion."

Keeping that compulsion somewhat


REED RAHN

in check can be a challenge. Lee Patterson admits he "kind of lost it" the afternoon that he suggested to his wife Cindy that it might be a good idea to cover the master bathtub with a nice piece of plywood and use it for parachute storage. "We hardly ever take baths," he explains, adding quickly, "we're shower people." Cindy realized at that point that his case was probably incurable and countered with a suggestion of her own: If they were to keep their marriage intact, they should find a much bigger house. Now, six years after their move, the collection fills the basement of their current home, and the Pattersons are facing another move to San Diego in 2000 to retire. "We'll have a smaller house," says Patterson. "Might as well, it would take a hangar to house this collection. Imagine 123 life-size mannequins with enough space to walk around each one and see all the gear."

Patterson's father was a World War I aviator who went on to manage an airport. Patterson says that moving from a military family into law enforcement was a natural progression for him and that he feels most comfortable in a disciplined and ordered life. Another collector, Dave Mattsson, saw his obsession begin in a family that was also involved with law enforcement and flight. Mattsson, a 36-year-old skydiving instructor, parachute rigger, and aircraft mechanic for Northwest Airlines, has been collecting ejection seats and associated life support gear since he made his first parachute jump at the age of 16, on a chute similar to the C-9 round parachute that Patterson started on.

Mattsson's father, a Minneapolis police officer and sailplane pilot, used to take "Little David," as he is still known at the drop zone, to his soaring club, which shared an airport with a skydiving club. "I remember all the times I saw grown men screaming 'Yahoo!' as they rode their canopies down," Mattsson says. "I wanted to understand what they were feeling and I wanted to try it myself." From a childhood spent with every kind of flying toy imaginable to his first jump and a coming of age at the drop zone, Mattsson says the allure of flight and ejection seats and survival equipment was unavoidable. "What I try to do now is keep the disease in check. A couple of years ago I got a Russian leather flight jacket. My first instinct was to complete the ensemble, to get a helmet and chute, et cetera. I caught myself and traded the jacket. That was close."

Mattsson lives in a Cape Cod-style house with a Holstein-marked cat named Tara and 13 mannequins dressed in flightsuits and survival gear that run the gamut from World War I to present. "I feel like a mortician dressing these stiffs," Mattsson says. A bachelor who makes a good living, Mattsson is an ideal collector, according to LeBeau. "I'd be a millionaire if it weren't for guys' wives," he laments. "I've had to send stuff to secret post office boxes. One guy told me he sifts dust from the vacuum cleaner bag onto new pieces in his collection, hoping his wife won't notice them."

Mattsson's appreciation for the equipment he collects extends beyond just admiring it in his basement—he sometimes jumps with a C-9 parachute taken from a Martin Baker ejection seat. A Federal Aviation Administration-cer-


ERIK HILDEBRANDT

*Opposite: Patterson helps Air Force survival technicians like Juan Toledo (at right) train aircrews. Dave Mattsson tends his collection (above). He also maintains live ejection seats for an air museum.*

LAURIE SKRIVAN

*Chad LeBeau sells survival equipment worldwide. Collectors consider his lavishly detailed catalogues bibles for the hobby.*

tified parachute rigger, he is an expert on the Martin Baker systems and spends several days every year giving a refresher course to the pilots and crews that maintain and fly the OV-1 Mohawks at the American Wings Air Museum at Anoka County Airport in Minnesota (see "The Last of the Mohawks," Feb./Mar. 1997). Mattsson's students zip up a flightsuit and don a helmet in preparation for strapping into the training seat and rehearsing ejection scenarios. After briefing the student on how the Mohawk's ejection seat works (including how the canopy on the OV-1 doesn't jettison prior to ejection—the seat punches right through it), he gently tests each student's knowledge, asking for a demonstration of the proper posture prior to ejection or how to prevent flailing injuries by keeping elbows tucked in tight while pulling the upper ejection handle, or face curtain. Mattsson has justifiable confidence in his equipment—the Martin Baker seats he maintains may be the most successful in the 55-year history of ejection seats (See "Ejection Seats, p. 65).

Mattsson assembled the 1,300 pieces of the Martin Baker seat he uses for his briefings from three decommissioned OV-1 Mohawk ejection seats, then modified the rigid, horseshoe-shaped parachute pack so that he could detach it from the seat to demonstrate the chute's deployment.

But the ultimate demonstration for Mattsson came in 1997, when he restored a C-9 parachute, which was used in Martin Baker seats, and started skydiving with a complete ensemble. He jumps from a Cessna at 12,500 feet wearing the "correct" helmet, oxygen mask, and flightsuit, and with a tether-bound life raft hanging beneath him that deploys and inflates on the way down, just as any pilot punching out on a Martin Baker seat would have. In his replication jumps he went so far as to wait in freefall for the automatic actuation device to open his parachute for him at 4,000 feet, a last-chance option for an unconscious pilot who couldn't pull his own ripcord.

When he's not jumping out of airplanes and relying on computer chips to pull his parachute, Mattsson gets his adrenaline rush from riding his high-performance "crotch rocket" motorcycle, aerodynamic as a fighter jet. "I love the feeling that I'm getting away with something that I shouldn't be able to do," explains Mattsson, a veteran of 1,200 jumps. "That's what ejection seats are all about. Instead of being dead in a wrecked jet, this equipment lets pilots get through their worst nightmare." Mattsson says his penchant for collecting life support systems and escape mechanisms probably comes from growing up in a household where his father went to work every day and the family tacitly acknowledged that he

might not make it home that night—a feeling that the other collectors also know something about.

Patterson's career in law enforcement included 10 years riding motorcycles—Harleys, Kawasakis, Moto Guzzis, BMWs, and models he assessed for police use. Risk taking, riding big motorcycles, skydiving, and law enforcement are also part of LeBeau's background. In addition to more than 2,400 skydives, he spent the early 1970s as a featured performer at airshows across the country, making car-to-plane transfers for $350 a weekend. "Pretty crazy," LeBeau recalls; "I'd crouch on the hood of a convertible facing backwards and a plane with a weighted ladder would fly over as we raced down a runway and I'd grab that ladder and the plane would try to fly away with me dangling under it. Once we had a clipped-wing Cub with a 65-horse engine and it ended up bouncing me three times off the runway before I could climb up into the cockpit. The pilot was slapping hell out of the fuselage, my signal to climb up, but I was having problems of my own, leaving little pieces of hide on the ground."

LeBeau, who could double for Kirk Douglas, regrets that he never made it to Hollywood to work as a stuntman. Instead, he went to school and studied law enforcement and retail security. "It wasn't very exciting," he says. "I didn't last long."

LeBeau found that even collecting survival gear can be risky. His closest call came a few years ago when he acquired a truckload of British-made aircraft instruments that were stored in an old warehouse in Benton Harbor, Michigan. He and a friend drove up from St. Louis to load the gauges and worked for an entire day sorting through broken and damaged pieces. That night, they noticed that their skin had reddened. "We'd been indoors all day and couldn't figure how we got sunburned," he says. Then they noticed that LeBeau's torso was still white under the metal snaps on his shirt. "Those old glow-in-the-dark radium faces on the instruments were radioactive. We got radiation burns." LeBeau, who won't sell anything he wouldn't have in his own collection, "got the hell out of there and never looked back."

LeBeau goes to greater lengths every year to add to his collection because the pool of surplus parts is shrinking. "The lawyers are scaring everyone, including the military," he says. "Thirty years ago all this stuff was just sold 'as is.' Then for a few years the military started asking itself, 'Could anyone possibly be hurt by this thing?' Now, instead of trying to figure that out, they just destroy everything that they don't have any use for."

Not long after the Persian Gulf War, the Department of Defense realized that it had scores of warehouses full of obsolete equipment meant to support a seven-year war. There was a huge sell-off, and people with a "buy a jeep for a buck" attitude started showing up at DRMO auctions. "They weren't collectors," LeBeau says. "They'd paid some ripoff artists hundreds of dollars to take a weekend seminar on how to buy surplus stuff and get rich. We used to see them at the auctions. The 'clipboard people,' we called them. The clipboards were the only thing of value they got at the seminars."

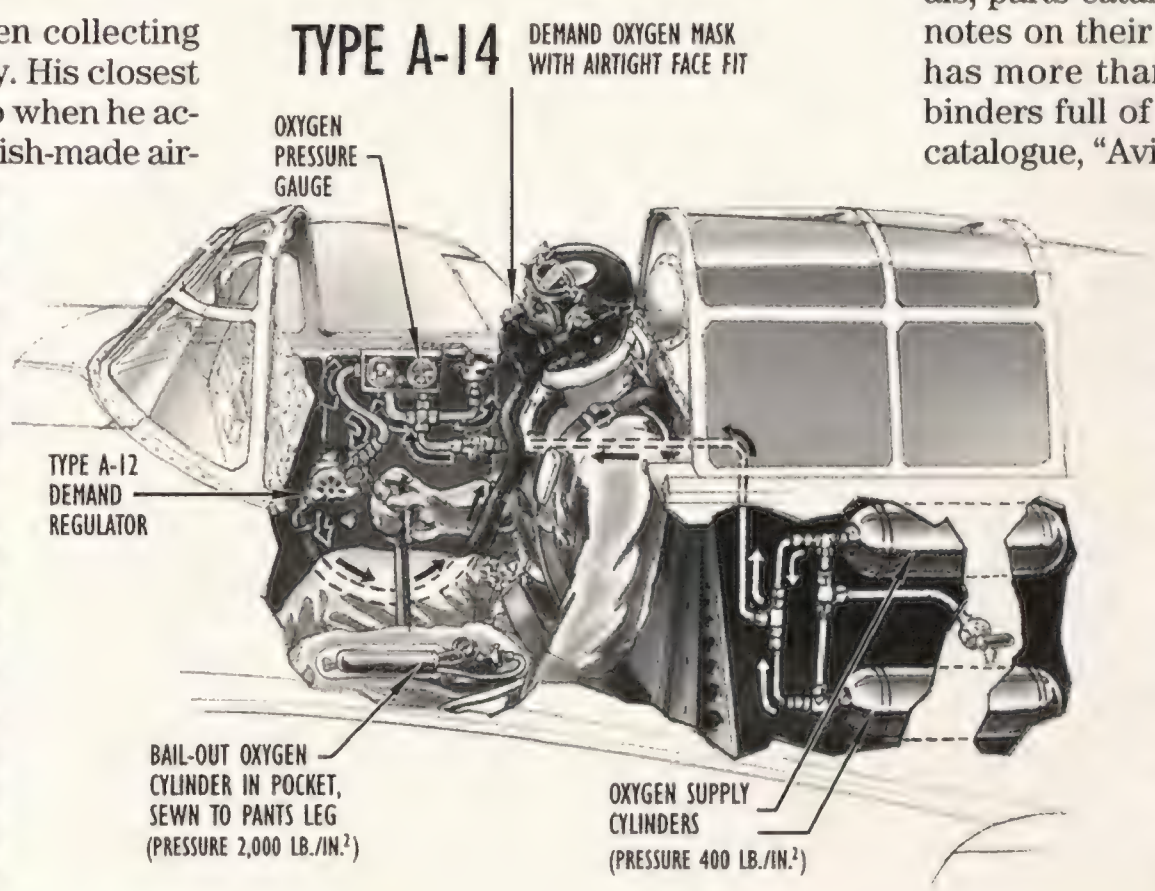
The get-rich stories are out there, but rare today. LeBeau's favorite is about a guy who bought a couple of hundred surplus aircraft after World War II for a million dollars. He drained the fuel out of them, LeBeau explains with an admiring chuckle, and sold it back to the government, earning a couple of million bucks for a month's work.

Besides similar backgrounds, Patterson and LeBeau share a nagging feeling that the whole preoccupation manifests a certain character defect, and that the hobby may be larger and darker than it appears. Patterson and Mattsson both refer to themselves as "obsessive-compulsive." Both men, in candid self-examination, used the improbably paired phrases "anal retentive" and "ejection seat" in the same sentence.

But theirs is a fascination of depth that includes years of study and cataloguing, a continual refining of expertise, and a constant insistence on accuracy and authenticity that few hobbies demand. All three men have dedicated untold hours of research to their mania and have acquired an encyclopedic knowledge of warbird survival equipment that spans six decades. They maintain libraries of technical manuals, parts catalogues, and volumes of notes on their collections. Patterson has more than 50 three-inch-thick binders full of information. LeBeau's catalogue, "Aviation Artifacts, Inc.," is a collectible in its own right. The didactic narratives he writes for every item in the catalogue are widely regarded as a reference work for collectors. But for all their studiousness, all three men refer to their hobbies as something weirder than, say, collecting fountain pens.

Out on the flightline at Luke, Patterson pokes his head into an F-16 cockpit while giving a quick description of

*A World War II-era pilot carried compressed oxygen aloft in canisters. Today's fighter jocks carry liquid oxygen, or LOX, which is converted to gas for breathing.*



NICOLAS HALSETH (2)

*Try this with your stamp collection: Mattsson, a skydiving instructor, jumps with the parachute and survival pack—including life raft—from a Martin Baker ejection seat. The seat's systems pull his parachute automatically.*

the ACES II ejection seat. He can look at any small part—a buckle, a piece of webbing, a bolt—and tell you the part number, where it was manufactured, how much it cost, and what it replaced. But while walking back into a hangar he reflects on what really keeps his obsession going. "That cockpit smell, did you notice it?" Not waiting for an answer, he says, "Strange combination: B.O., jet fuel, wiring, hydraulic fluid. I sure like the attached memories. I smelled that in cargo planes, jump planes, police helicopters, and my blood pressure jumps a couple notches every time."

Patterson is unusual among most collectors in that he served in the Air Force during the Vietnam War, "ferrying parts and people over there in C-141s and bringing bodies back," he says. In general, collecting survival equipment is not a hobby dominated by people who actually used the items in flight. The pilots and aircrews don't seem compelled to revisit and collect reminders of that period of their lives. "The pilots talk about spending endless hours in uncomfortable seats with helmet headaches and throbbing feet, and they aren't too nostalgic," LeBeau explains. "Less than five percent of my customers actually used this stuff."

The longing to possess a piece of military history seems to be linked to the coming of age rituals and "testing one's mettle" that combat survivors have gone through. For noncombatants, there's a compulsion to connect with the courage, the patriotism, the camaraderie and discipline that, ideally, military service embodies. The accoutrements, certain colors and fabrics, certain smells, and the tools and furniture of war can be helpful when trying to get in touch with one's inner soldier.

In 15 years of dealing, LeBeau has made one sale to a woman: a piece of parachute harness. "These really are boy toys," he says. "Most women are either indifferent to this stuff, or, in the case of married women, they hate it. They look at a helmet and would rather see a piece of jewelry."

The best thing that happened to LeBeau's then-fledgling business was the release of *Top Gun*, in 1986, after which an obscure hobby went more or less mainstream. "Collectors get turned on to this stuff because of movies, fantasy," LeBeau believes. "Of course Hollywood doesn't give a damn about authenticity, but people see something like *Top Gun* and everybody wants to be Maverick or Goose or Iceman. There are clubs in California where guys get dressed up in this stuff and say lines from the movie to each other. Don't talk to Lee Patterson about that. He'll tell you that those guys are wrecking historic equipment. He's probably right."

Many collectors with whom LeBeau deals are intensely private about their hobby. "A lot of guys are hesitant to talk about it on the phone," he says. "They won't leave a message. I tell them it's okay to talk about it and that seems to open them up a bit." In 1997, Nashville-based collector Rich Mays tried to start a newsletter for ejection equipment collectors. "For others who have the mutant gene that causes us to spend good money (often LOTS of it) on the strangest things, YOU ARE NOT ALONE!" the masthead read. He sent the first edition of the newsletter to hundreds of collectors, but it became apparent

that they wanted to enjoy their hobby in solitude. The newsletter folded after the first issue.

"Except for those guys in California, collectors of this stuff keep it quiet. It's something they do in their basement, by themselves," LeBeau says.

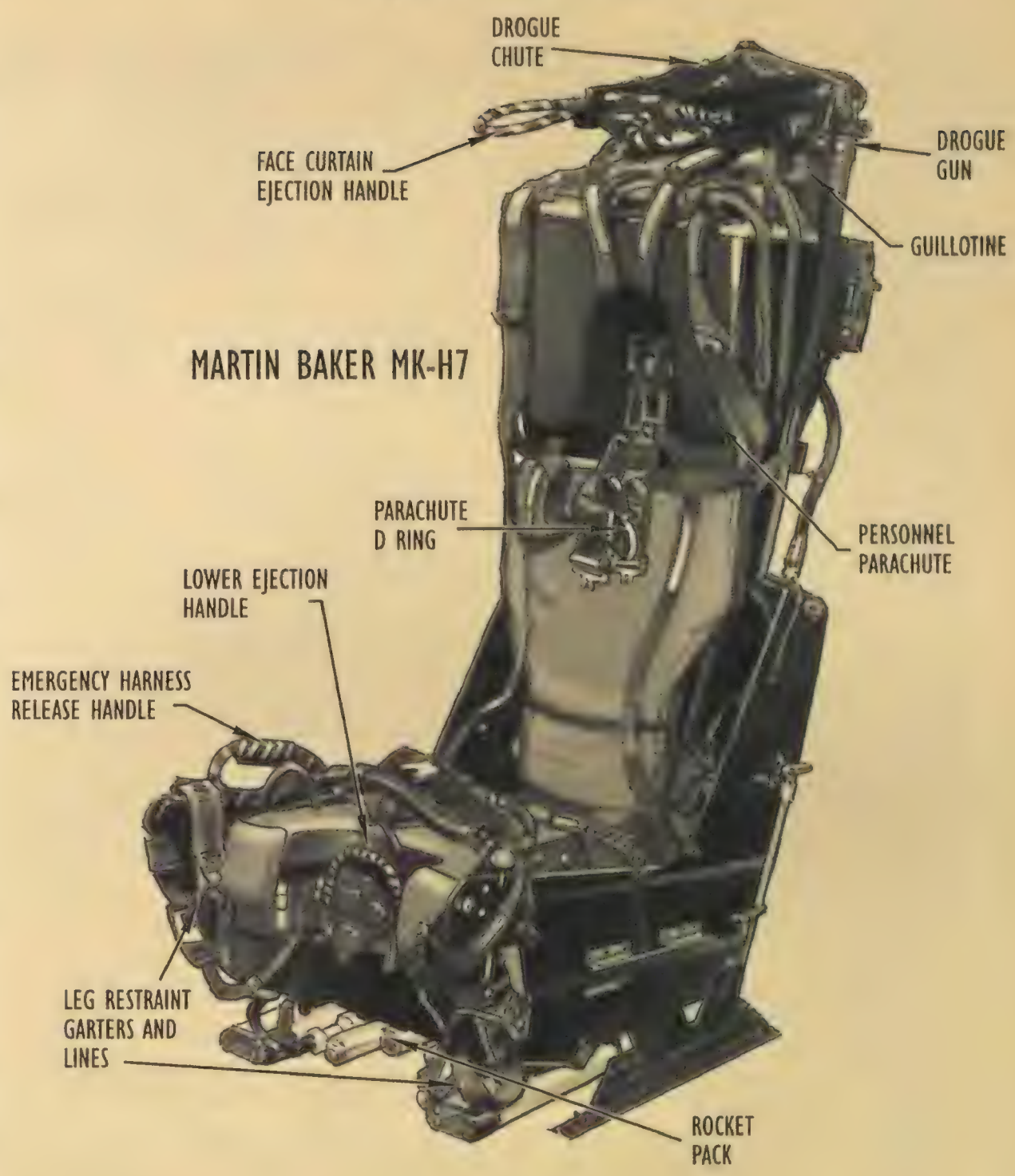
Patterson's collection begins on the walls of the stairway to his basement. "That's where Cindy draws the line. That's probably a real good idea," he says. Mattsson, ascetic for a bachelor, imposes the same rule on himself. LeBeau, who has never been married, is much less restrained. As a dealer, he often buys his stock by the truckload at DRMO sales, and he has filled three you-store-it sheds and two warehouses. His home is nearly filled with survival gear stacked as high as he can pile it, including one room that contains his personal collection, in which there is just enough room to place one's feet while keeping elbows tucked in and viewing thousands of objects. "This room is full of priceless stuff," he says. "Actually, I could put a price on it, but it would take somebody like John Travolta to buy it and keep it all together." LeBeau keeps pathways cleared between the kitchen, bedroom, office, and bathroom. It looks like he could, in good faith, write the whole house off as a business expense—just another warehouse.

When Patterson explains that his collection is priceless, you believe him. "I don't know what all this stuff is worth," he says. "I hope to donate it to a museum someday, a place that could display all of it." In the meantime, most of Patterson's collection is stored in "correct" gear bags in a large, secure room in his basement. "I could put a price tag on each piece and sell it off, but intact, it's invaluable," he says. He pauses and laughs. "If something happens to me, well, Cindy will sell everything and be rich."

Mattsson recalls moving his growing collection from one apartment to the next until he bought a house six years ago. He doesn't relish the thought of another move, and can't predict what the future of his collection will be.

"I can tell you," LeBeau says. "Someday he'll get married and six months later he'll be trying to sell the whole collection. I guarandamntee it."

# EJECTION SEATS




Martin Baker ejection seats, built in Middlesex, England, were installed on U.S. Air Force and Navy F-4 Phantoms. The latest models are found aboard the F-14 Tomcat, F/A-18 Hornet, and T-45 Goshawk. The company has manufactured more than 68,000 seats, and can boast of more than 6,700 lives saved and a successful deployment rate of 94.4 percent. In Russia, the Zvesda (Star) factory produces seats that perform as well as Martin Baker's—Zvesda seats are being tested by the U.S. Navy and Air Force for possible use. American-made ACES II seats, now built by Boeing, are currently installed in F-15s, F-16s, B-1s, B-2s, F-117s, A-10s, and F-22s. As of May 1997, ACES II seats had been successfully deployed 476 times, with success rates similar to those of Zvesdas and Martin Bakers. The ACES II can automatically adjust its chute deployment to suit conditions. In Mode 1, which can take place at zero altitude or airspeeds from zero to 250 knots, the ACES II catapults the pilot to 200 feet at 12 Gs and deploys the parachute within two seconds. In Mode 2, which is effective up to 600 knots—the maximum speed at which a crewman can eject in the seat—the seat deploys the main chute in six seconds after a drogue chute has stabilized the man-seat package. In Mode 3, which is typically selected above 15,000 feet, the seat's sensors delay the chute deployment until the man-seat package reaches Mode 1 or 2 conditions. Parameters for each mode overlap—in each ejection, the ACES II senses its own speed and altitude and selects the best mode for the crew member's survival.

# NASA's Art Rides the Rails


## A rolling exhibit brings space exploration to small-town America.

by Constance Bond
*Photographs by Tyler Mallory*

It was one of those in-between moments: I was surveying the scene in the parking lot next to the railroad crossing in Taneytown, Maryland, an unspoiled pre-Revolutionary War town of about 5,000 souls. For a while I chatted with Chief Melvin Diggs, who had pulled up next to me in a patrol car to see if I was up to no good. He'd been keeping an eye on the open tents behind me filled with work by local artists. But the main attraction was stretched out behind him on the tracks, raked by the late afternoon sun—the four windowless cars and caboose of Artrain.

Inside the train was an exhibit—78 works of art commissioned by the National Aeronautics and Space Administration, the people who took us to the moon. This was the first stop of a three-year, 48-state tour, and the big track-side opening was to be in a couple of hours. But now the place was deserted. Even the shaved-ice vendor, who'd handed out bright red and purple cones to the local artists while they set up their displays, had taken off.

*"The Light Ship" (1984) by Attila Hejja is one of 78 works of NASA-sponsored art in the Artrain show, which opened its 1999 tour to about as big a crowd as little Taneytown, Maryland, could muster (above).*

ALL ART COURTESY NASA

Everybody, it seemed, was home getting ready.

Like many of the 600 communities that Artrain has visited since its birth in Michigan 28 years ago, Taneytown does not have its own art museum. So folks throughout Carroll County—from the local merchants and the owner of Maryland Midland Railway to the arts council and the students of nearby Bowling Brook Academy—had pulled together to make the five-day visit of the non-profit rail-riding museum a success. Even the docents who would welcome visitors to the train were local—all are volunteers taught by an Artrain staff member.

It's a great idea—using a train to bring art to people who might not otherwise see it. And in fact, "The Artistry of Space"—the exhibition now on board Artrain—was sparked by a similar populist vision. In 1962, NASA Administrator James Webb decided to make artists a part of the space program. For a modest honorarium, they were invited to come to Cape Canaveral or one of the other NASA facilities, bring their drawing or painting tools, have the run of the place with the help of a guide, and then somehow re-create their experiences in art. In the 37 years since, more than 250 artists have documented the Space Age, climbing the huge red gantries that so fascinated them in the early years, trudging through meandering wetlands that surround the launch pads in search of the perfect vantage point, and sitting around with suited-up astronauts in the last minutes before final word to board—all the while sketching, painting, or reflecting on what they'd seen.

Now, with the support of current NASA Administrator Dan Goldin, and under the national sponsorship of Daimler-Chrysler, a selection of these works has been loaned by NASA and the National Air and Space Museum for this rail tour. The traveling collection depicts the Soviet-American race to the moon, voyages to the planets by unmanned spacecraft, and the flights of the space shuttles.

Some of the artists—Norman Rockwell, Robert Rauschenberg, Andy Warhol—are well known; some are not. Some works are in the grand 19th century landscape tradition, such as "The Light Ship" by Attila Hejja, which portrays, amid dramatic billows of steam and a blazing trail, the first night launch of the shuttle *Challenger* in 1983. Other works are abstract meditations on Saturn's rings, Neptune's surface, the Amazon basin as seen from space. There are simple still lifes, such as a graphite rendering of an astronaut's glove lying palm-down, its subtle wrinkles evidence that space exploration is hard work. There is even a dress, to be viewed with 3-D glasses, by fashion designer Stephen Sprouse, its pattern derived from imagery of the Mars Pathfinder mission. In short, there is—as was James Webb's intention—something for everyone.

And, judging by the long line that stretched along the tracks the morning after the opening, everyone was there. On the train, people of all ages, some with school-age kids, stood in front of the artworks, talking, pointing, reminiscing.

A retired biologist, Robert Thomas, with whom I had talked earlier, but-

*Clockwise from left: "Vacancy" (1982) by Chet Jezierski and "Challenger in White" (1986) by Greg Mort express the human struggle in spaceflight, a theme echoed in a portrait by Pamela Lee on view inside the train car.*


*The Artrain flashes a decal of Andy Warhol's "Moonwalk (1)." Art patrons (below and above, right) find the train more fun than museums, especially when viewing is enhanced by 3-D glasses and human props.*

tonholed me, pulling me over to "The Light Ship." "That's what we remember—the impression of power, the steam," he said with passion, "not the hardware."

Nearby, an elderly man examined two works for a long time—the still life of the astronaut's glove and a pencil sketch by Henry Casselli of astronaut Shannon Lucid pulling on a glove, perhaps while training for her tour on the Russian space station Mir. Hanging the two works side by side was one of many inspired groupings by the show's curator, Susan Lawson-Bell. "Sort of brings it all alive, doesn't it?" he remarked to me.

In the first car, devoted to the race to the moon, Susan Heck and her two teenage daughters stopped in front of Robert McCall's "Splashdown." In this celebratory lithograph, the capsule carrying the Apollo 11 astronauts back to Earth after the successful moon landing has just fallen into the deep-blue ocean. Above the capsule, billowing red-and-white-striped parachutes slough off air; on the far horizon, a ship waits. Heck, who recruited the docents for the exhibit, pointed to the capsule, then to the ship. A few moments later she explained to me, "My kids were asking, 'What's that?' and they didn't even notice the ship waiting in the background. They only remember the shuttle." She laughed. "I'm surprised how much I could explain to them. I mean, I *lived* through this!" As the three of them moved on, Heck said to me over her shoulder, "They want to see the paintings with the backpacks again."

That would be the MMUs, Manned Maneuvering Units. To my surprise, there was a docent on the train, Shirley Prutch, who knew a great deal about them. Her remarks as people came on board were spirited ("...we were not only going to the moon, we were going to land on the moon, and we were going to return from the moon, and yes, we were going to do it before Russia..."). Turns out that Prutch had headed the division "at Martin" that developed the software for the maneuvering units. ("My dad worked for Martin before I did," she told me, "and I don't say 'Martin Marietta' or 'Lockheed Martin'; it'll always just be Martin to me.") With the help of two paintings portraying extravehicular activity—"Working in Space" by Linda Draper and "Premiere Flight of Endeavour" by Howard Koslow—she explained to me how the MMUs worked. I realized then that the "Artistry of Space" exhibit would probably reach a lot of the people who had worked in the space program and that, like Prutch, they would see the art, remember their careers, and explain what they did to friends and neighbors, all across the country.

## Artistry of Space
## Artrain's January–June 2000 Schedule

Kennedy Space Center, FL ..... Jan 20–23
Fort Myers, FL ..... Jan 29–Feb 1
St. Petersburg, FL ..... Feb 5–8
Palatka, FL ..... Feb 12–16
Pelham, GA ..... Feb 23–27
Opelika, AL ..... Mar 4–7
Spartanburg, SC ..... Mar 10–13
Conway, SC ..... Mar 18–23
Albermarle, NC ..... Mar 30–Apr 2
Ayden, NC ..... Apr 13–16
Elkin, NC ..... Apr 27–30
Danville, VA ..... May 4–7
Norfolk, VA ..... May 11–14
Pulaski, VA ..... May 18–21
Tullahoma, TN ..... May 25–29
Watertown, TN ..... June 1–4
Cookeville, TN ..... June 8–11
Nicholasville, KY ..... June 22–25

### Selected Works in the Exhibit

"Apollo 16 Sketchbook" (1972), Alan Cober
"Man on the Moon" (1989), Peter Max
"Neptune and the Fire of Knowledge" (1990), Andreas Nottebohm
"Flight of Columbia" (1981), Jack Perlmutter
"Stoned Moon Series: Earth Crust" (1969), Robert Rauschenberg
"Man's First Step on the Moon" (1966), Norman Rockwell
"Support" (1965), James Browning Wyeth

# The Coldest Warriors

## Tales from the corridors of an agency so secret that officially it didn't exist.

*by William E. Burrows*

On August 18, 1960, the first operational U.S. spy satellite snapped scores of pictures of forbidden places in the heart of the Soviet Union. The high-flying sentinel and its successors, known by the suitably ambiguous name Discoverer, were part of a top-secret program called Corona, and they started a revolution in intelligence by returning to Earth film that contained unprecedented detail about the Russians' fiercely protected military structure and facilities.

Air Force generals who had been indifferent toward spying from space changed their minds about the value of satellites when eye-popping photographs of Soviet bombers and missiles, submarines and cruisers, tanks, airfields, nuclear test sites, navy yards—more targets than they'd ever seen—began floating down out of the blue. And old hands at the Central Intelligence Agency saw that a new era was at hand.

"For the analysts and estimators," the CIA's Albert D. "Bud" Wheelon would write years later, "it was as if an enormous floodlight had been turned on in a darkened warehouse." But with the floodlight came the inevitable question of who would get to aim it, and shortly after the first dramatic triumphs of Corona, a battle for control of the country's intelligence assets erupted. The beginning of the long reconnaissance war coincided roughly with the creation in 1961 of a secret organization—the National Reconnaissance Office—to manage all spyplanes and satellites under a National Reconnaissance Program. Perhaps more relevantly, the start of hostilities also coincided with the departure from public service of Richard M. Bissell Jr., the CIA's assistant director for plans and development under Director Allen W. Dulles.

Bissell was part of the brainy club of scientists, engineers, and high-level bureaucrats who thought up the Corona program. Other members included Polaroid's Edwin "Din" Land, Harvard's James Baker and Edward Purcell, RAND Corporation's Merton E. Davies and Amrom Katz, and MIT's president, James R. Killian. These men worked together so congenially that they amounted to a fraternity of grown-up whiz kids, but it was Bissell who set the tone of the program.

The scion of Connecticut insurance Brahmins, Bissell was a courtly, mild-mannered guy who ran the Idealist (U-2) and then the supersonic Oxcart (A-12) spyplane programs. He believed in spartan, streamlined command systems, small staffs, collegiality, and generous funding from a pocket that was

*The "generals" of the recon wars, both external and internal (top row, from left): Richard Bissell, Joseph Charyk, Albert Wheelon; lower: Robert McNamara, Edwin Land, Alexander Flax.*

PHOTO ILLUSTRATION BY RANDY MAYS; PHOTOS: CORBIS, BETTMANN, WIDE WORLD, DWAYNE DAY, NRO

deep, black, and free of red tape. Bissell's U.S. Air Force counterpart in Corona was Brigadier General Osmund J. Ritland, the vice commander of the Ballistic Missile Division.

By all accounts, the two worked well together and got things done. Bissell had firm control of Corona, but he, Ritland, and others communicated with a chat and a handshake instead of directives and memos. "Imprecise statements of who was to do what permitted a range of interpretations; however, vague statements of responsibilities caused no appreciable difficulties in the early years of Corona," reports *The Corona Story*, a history of the program by Frederick C. E. Oder, James C. Fitzpatrick, and Paul E. Worthman published by the NRO and declassified in 1997. "The organization was small and had a single concern: producing a reconnaissance satellite. Much later (1963–65) those loose statements were analyzed more parochially and became a source of friction between the CIA and [the Department of Defense]."

President Dwight Eisenhower ordered the creation of the Office of Missile and Satellite Systems within days of the first successful Corona flight. Eisenhower, wary of inter-service rivalries, wanted the OMSS to coordinate and streamline Corona and follow-on space reconnaissance programs. The office was supposed to ensure that such programs were national in scope rather than serving the narrow needs of one or two military services—and he wanted it run by civilians. Ike insisted that Corona and its successors disappear in the ultra-secret world. No sense in rubbing sensitive Russian noses in the fact that many of their deepest secrets were being laid bare.

The OMSS was superseded without ceremony on September 6, 1961, by the National Reconnaissance Office. Its creation formalized an agreement worked out earlier by Bissell and Undersecretary of the Air Force Joseph V. Charyk during the Idealist-Oxcart-Corona partnership. The NRO was to be run by two civilians: the undersecretary of the Air Force and the CIA's deputy director for plans, both "acting jointly" for the benefit of all the services. That meant buying satellites, supervising their design and development, and operating them. With the arrival of the Kennedy administration and some predictable changes in directors, Bissell departed, and Charyk became sole director of the NRO. He created three separate domains: program A, to develop Air Force satellites, Program B, to develop satellites for the CIA and run the agency's air operations, and Program C, for the Navy's ocean reconnaissance satellites. A fourth, Program D, covered aircraft. Creation of the fiefdoms would lead to intense competition, some of it brilliantly constructive. But some was intensely destructive.

The CIA-Department of Defense directive establishing the NRO assumed that the informal style of doing things would continue. It made no reference to a single director. After Bissell left government early in 1962, the reconnaissance hierarchy, deprived of his harmonious presence, became mired in a conflict between the Department of Defense, the Air Force, and the CIA. If an intimate look at one family can portray an epoch, as Dickens and Tolstoy believed, then events within the NRO serve as a telling portrait of the U.S. intelligence community during the cold war and its aftermath.

From the beginning, the NRO was cloaked in utmost secrecy. Its cover was the Pentagon-based Office of Space Systems. It drew its personnel almost exclusively from other organizations, notably the Air Force and the CIA, and almost everybody in Room 4C956, the NRO's tightly protected sanctum in the Pentagon, was borrowed from someplace else. Even the logo on its letterhead (a spherical satellite that ironically resembled Sputnik orbiting Earth) was classified. Mere mention of the organization's name was absolutely forbidden. Officially, the National Reconnaissance Office did not exist.

The NRO's subsequent history was marked by extraordinary spy satellites funded by huge, hidden budgets and developed by scientists, engineers, and administrators who formed a cat's cradle of daring held taut by technical brilliance, bitter competition, and intrigue. The internal wars were caused by sharp differences over how the reconnaissance "product" was to be used, how the satellites were to be procured and

DWAYNE DAY COLLECTION (2)

*This Thor-Agena booster being raised to the launch position will shortly send a Corona on its way from Vandenberg Air Force Base (left). A fine day at Kapustin Yar: The puffy clouds over this important Soviet missile launch site were a recurring problem, and they obscured the view of image interpreters (opposite).*


operated, and how power in the NRO itself was to be allocated. It all boiled down to seizing and protecting turf that was valuable both economically and politically. "The Air Force was driven early by what was going to be instantly usable for war-fighting," says Admiral Bobby R. Inman, a soft-spoken former director of naval intelligence, the National Security Agency, and deputy director of the CIA. As Inman sees it, the airmen wanted information on enemy deployment—its order of battle—and what it took to win a war. The Air Force believed, as did the CIA and successive presidents, that the best way to prevent a war was to acquire excellent intelligence. The difference had to do with focus.

"The CIA [was driven] more by what was going to give information on unanswered questions—what would facilitate moving forward on arms control, as an example," Inman says. Bud Wheelon, who was the CIA's first deputy director for science and technology from 1963 to 1966 and ran the agency's spy satellite and aerial reconnaissance programs, agrees. "It was a roles and missions fight," he says. No CIA operative was ever going to be sent to bomb Vladivostok or shoot down MiGs. The agency's job was to produce long-term estimates of Soviet and other potential enemies' strategic capabilities.

An example of the continuing conflict between the two priorities was evident as recently as January 1991, just before the Persian Gulf War. For a period of four days, General Norman Schwarzkopf, commander of the coalition forces, monopolized reconnaissance satellites to map the area in Iraq where his troops would engage the enemy. That angered his counterparts in the other services and in the CIA.

Satellite procurement was another battleground. The CIA had very flexible procurement rules, moved money quickly, had close working relationships with contractors, and took chances. That approach had worked famously during development of two spyplanes (see "That New Black Magic," Dec. 1998/Jan. 1999 and "The Oxcart Cometh," Feb./Mar. 1999). The Pentagon was buried under mountains of procurement rules and, in Inman's view, was under enormous pressure from Congress not to make mistakes. (The spooks' mistakes were more easily hidden.) The agency, somewhat arrogantly but justifiably, thought it deserved the right to call the shots on spy satellites and the aerial reconnaissance programs. Inman notes that the CIA had a fundamental stake in intelligence and was therefore doubly determined to control the system because, to use his word, it was an end "user."

That led to disagreement over how the NRO was to be run. Charyk, the first director, believed that spying from space ought to be controlled by the NRO—his office—because a tidy and efficient setup prevented anarchy. He wanted tight control from the top—a "chief executive officer" approach.

Herbert "Pete" Scoville Jr., who succeeded Bissell but did not enjoy his clout, was just as determined that the CIA be the master of the intelligence-

## How Things Worked

Today, the development of spyplanes and satellites normally begins within the United States Intelligence Board, whose members represent all of the nation's intelligence organizations. The first step in the creative process, as in other kinds of engineering, is defining the requirement, which is framed by the board and sent to the NRO, where scientists and engineers mull over ways to fulfill it. Then they share their ideas with those who will use the intelligence and with the contractors. This interactive process involves the CIA, the military (the Air Force launches and controls satellites, while all of the services need the intelligence), and prime contractors such as Lockheed Martin, TRW, and Hughes Aircraft. The NRO pays for the spacecraft through secret budgets on the Department of Defense's books and operates them through the Air Force.

"The agency brought to the business a group of people, like myself, who were former industrial people who knew how the process worked, who weren't afraid of technology, and who were prepared to engage in a dialogue with the contractors to make the various choices," retired CIA officer Bud Wheelon explains. Many of the NRO staff come from contractors, universities, or applied physics labs and know as much about spacecraft construction and operations as the contractors do. "When a decision had to be made, or a direction chosen...it was all done by the agency people and then it shifted to the contractors," says Wheelon. The CIA is supposed to come up with breakthrough concepts to solve specific problems. The contractors add their own ideas and then develop the finished product. Insiders have characterized the contractors, the NRO, and its constituents as a very small, cozy group; some have described the relationship as incestuous. The prime contractors, in effect, are as dependent upon the NRO as the NRO is on them. "Occasionally the companies would come up with new ideas and new approaches and would come in to offer some totally different way you could do something," says intelligence veteran Bobby Inman. Usually there was enormous resistance, he says, describing the NRO attitude as "Stay with what we're telling you to work on; don't come and tell us about other things you could do." He adds: "The companies were not reluctant to make end runs to higher places" to peddle their wares.

collecting house because that was the agency's inherent responsibility. Scoville and his successor, Wheelon, took what can be called a "chairman of the board" approach: The NRO should loosely preside over its various constituencies, let the CIA tell the satellite contractors what was needed, and give them plenty of money. He and Wheelon fought with both Charyk and Charyk's successor, Brockway McMillan, who arrived in March 1963.

The security cover under which the NRO operated disguised the fact that its director was the special assistant for reconnaissance to the new Secretary of Defense, Robert McNamara. It seemed a sensible idea to locate the office within the Air Force section of the Pentagon and provide cover for the NRO staff members with Air Force designations. The idea backfired, in part because the personalities changed, but also because the CIA had been reorganized after Bissell left. Now the CIA began to complain openly about the way the NRO was run. *The Corona Story* recounts: "It became convenient for a CIA representative to complain to Secretary McNamara about the offenses 'of the Air Force'; it would have required a good deal of courage to substitute the words 'of your office.' "

Scoville, who technically represented the CIA in the NRO and was in charge of Program B, had delegated that assignment from the beginning of his tenure in 1962 and absolutely refused to work on the NRO's premises in the Pentagon. "By late October 1962, he [Scoville] and Charyk were no longer willing to talk directly to one another; written correspondence from one to the other, even of the most formal kind, stopped shortly thereafter," according to Robert L. Perry's *Management of the National Reconnaissance Program, 1960–1965*, another recently declassified NRO history. Scoville had become convinced that the NRO was an instrument of the Air Force aimed at pirating Corona and other CIA programs. Lacking support from John A. McCone, who had replaced Dulles as director of central intelligence, he grew increasingly weary and disillusioned and left the agency in June 1963.

But Pete Scoville was mistaken about collusion between the NRO and the Air Force. Soon after McNamara became secretary of defense in early 1961, he began to cut Air Force programs. Steel-willed, he tried to move an unsuccessful Air Force satellite program called Samos, and the Air Force's supporting role in Corona, to the NRO. The air staff felt betrayed. The Air Force and the NRO both operated within the Department of Defense, but that did not make them allies. "So, from the beginning, the NRO was an abomination in the eyes of the Air Force and Air Force officers selected to man the NRO knew that they did so at their own career risk," recounts *The Corona Story*. Ironically, the account reports, a stint in the NRO could damage the careers of spies as well as airmen, since each side thought the NRO was in the other's political pocket. The air staff "looked on the NRO group as a not-quite-respectable collection of dissenters under the thumb of the CIA," with the result that Air Force officers who were "wholly loyal" to their NRO responsibilities sometimes felt that the "regular" Air Force had cast them out. Likewise, at least one CIA staffer who was assigned to the NRO and embraced its spirit found himself effectively frozen out of his own agency. "To be assigned to the NRO in any capacity, particularly in the troubled days between 1963 and 1966, was not uniformly looked on as a wholly happy circumstance," stated NRO historians in *Management of the National Reconnaissance Program, 1960–1965*.

The Navy was in the fray too, according to Inman. The sailors had their own fleet of spacecraft to handle communication, navigation, ocean reconnaissance, and other orbital chores. The Navy had wanted its Naval Research Laboratory to design and build satellites for programs such as White Cloud and Clipper Bow. "The NRO wanted to make sure that they were all commercially done," Inman says.

Program C, the Navy's ocean reconnaissance operation, reacted to the maelstrom by distancing itself from the NRO and pretty much going its own way, though Martin Marietta eventu-

LOCKHEED MARTIN CORP

*Film "buckets" from Corona satellites reentered the atmosphere and drifted down under parachutes (opposite) to be snagged in midair by C-119 and, later, C-130 aircraft. Such occasions attracted brass like some nonferrous magnet.*

ally got a contract for surveillance satellites. Wheelon, who at 23 had gotten a Ph.D. in physics from the Massachusetts Institute of Technology, replaced Scoville in 1963. Like Bissell and Scoville, he saw space reconnaissance as a valuable intelligence tool and told McCone as forcefully as he could that the agency had to play a pivotal role in the program—that strategic reconnaissance was primarily the agency's job.

Since the old intimate partnership with the Air Force was ancient history, Wheelon advised his boss, competition was the only alternative. McCone was already coming to the conclusion that the CIA had lost its influence within the NRO during the Scoville years, but the NRO had only increased its hold over satellite reconnaissance during that time. Something had to be done to get the CIA back in the satellite business, but the agency would have to do better than Corona. Now spoiling to compete, McCone got the ear of Jerome Wiesner, President John F. Kennedy's science advisor, and the highly influential "Din" Land, both of whom supported the CIA.

The tumultuous period from 1963 through 1965 saw the greatest breakthrough in space espionage since spy satellites started flying. First called Kennan and later Crystal, the famous KH-11 satellite sent imagery in near real-time—virtually as an event occurred. The KH-11 had its genesis in an improbable convergence of Soviet ballistic missiles and American football. On an autumn Sunday in 1963, Wheelon sat in his living room in Annandale, Virginia, watching a football game broadcast from San Francisco. He recalled that not one useful photograph had been obtained by Corona during the missile crisis in Cuba the previous October. By the time the returning film capsules had been snatched in mid-air, their film sent to Eastman Kodak in Rochester for processing, and the pictures forwarded to Washington for analysis, the crisis was over. It struck Wheelon that if an NFL game could be transmitted live from San Francisco, so could imagery from the Soviet Union and elsewhere.

Wheelon would need the newly invented charge-coupled device, then being developed at Bell Labs. A CCD is

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an electronic retina: a mosaic of many thousands of tiny light sensors that is no bigger than a postage stamp. CCDs convert photons of light to electrical signals that can be transmitted digitally. It took 13 years before the first Kennan was forward-passed into orbit. Part of the delay involved engineering, since the Greyhound bus-size spacecraft was fantastically complicated. But as usual, part was political.

A few months before Wheelon's football revelation, the Air Force tried to leapfrog the CIA by sending up Gambit, an advanced bucket-dropper like Corona but with outstanding resolution on the order of 18 inches. Kennan, the CIA's entry, had that kind of resolution and better, but it also had the tremendous benefit of sending imagery right away. Kennan therefore threatened Gambit, and that set off yet another bruising conflict. The Air Force reacted by trying to orbit Frog (for "Film Readout Gambit"). The idea was to scan Gambit imagery with an older vacuum tube video camera, but transmission from orbit was notoriously poor, which is why Kennan used CCDs.

Frog also had to fly low to get the clearest possible pictures of the target, but that made it more difficult to maintain line-of-sight radio contact with its receiving station. The spacecraft could operate only a few hundred miles inside the Soviet Union, and receivers to collect its imagery would have to be set up like a fence of antennas encircling the Iron Curtain. The advantage of using satellites instead of airplanes to get deep, complete coverage would be lost. The myopic Frog soon croaked.

The Air Force didn't have a monopoly on harebrained ideas, however. The CIA decided that the ultimate spy satellite should be able to do everything. It therefore invented one that combined imaging, including infrared, and signals intercept capability in a single colossally large and horrendously expensive vehicle. Even before it was killed on the drawing board, its many detractors contemptuously dubbed it "Battlestar Galactica."

Alexander H. Flax, the assistant secretary of the Air Force for research and development, succeeded McMillan as the NRO's third director on October 1, 1965, and stayed until March 1969. Flax concluded that the only way to get real-time imagery from deep in the heart of Russia was to beam it up to a second satellite, which would relay the pictures to Earth. A look at a globe of the world showed that the only feasible way to send imagery from the Soviet Union to the United States was by using a relay satellite in an elliptical orbit thousands of miles above the top of the planet, giving it 12 hours or more of "hang time" to collect the imagery and forward it home. This was done by a spacecraft known as SDS, for Satellite Data System, which was developed in close conjunction with Kennan to form a compatible team.

Another brilliant development during the 1960s was Rhyolite, a satellite designed to listen to telemetry coming from Soviet rockets and ballistic missiles as they lifted off their launch pads. Telemetry at launch—information about fuel flow, exhaust pressure, turbopump operation, guidance systems, and other vital signs radioed to the engineers—provides a complete picture of the missile's performance.

The CIA needed to intercept the telemetry just before and during liftoff. The solution was to park a satellite with a huge antenna over the launch site and eavesdrop on the telemetry, soaking it up on recorders like a mechanical sponge. The best place to do that was at geosynchronous altitude,

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*Snow can conceal—but in this case reveals—a surface-to-air-missile site. Interpreters looked for geometric shapes as evidence of man-made structure. For years even the identities of satellite recon personnel were top secret—the masked people in the picture are discussing launches—but today, the NRO's new headquarters is highly visible (opposite).*

roughly 22,300 miles up, where the satellite would remain parked over the same spot. But capturing a signal from so great a distance required a huge bowl-shaped antenna. That created another problem: how to get the thing into a launch vehicle's small upper stage. A contractor solved the problem by folding the antenna like a sophisticated parasol. Rhyolite was built by TRW and first launched in 1970. It was sensationally effective at listening to missile launch telemetry and monitoring thousands of radio conversations simultaneously.

While the rivalries of the early '60s resulted in solutions that were often brilliant, by 1965 the atmosphere within the NRO and the relationship between Defense and the CIA had deteriorated so badly that McNamara and McCone finally agreed to establish a National Reconnaissance Executive Committee chaired by the director of central intelligence and reporting to the secretary of defense on the NRO's research, development, and budget. If the DCI disagreed with the secretary of defense, he could take the matter to the president. At the same time, McNamara and McCone accepted three written peace agreements as well as "monitors" from each camp to make sure the terms of the agreements were

NRO

being met. That helped ease the tension. So did Al Flax, who firmly believed that the Air Force and CIA were complementary assets. He too tried hard to reconcile their differences.

A final agreement was signed on August 11, 1965, by Deputy Secretary of Defense Cyrus Vance and Admiral William F. Raborn, the new director of central intelligence. It established the NRO as a separate agency within the Department of Defense. Significantly, it also substantially reduced its director's authority and made the CIA responsible for establishing intelligence collection requirements and priorities. The CIA had won.

What was remarkable was that the convulsive power struggles of the 1960s spawned a highly effective system. However contentious the participants were in the beginning, the National Reconnaissance Program forced them to focus on the overall intelligence problem in an extraordinarily creative (and financially lush) environment.

In the 30 years after the Vance-Raborn agreement, the NRO's cover of secrecy was gradually torn away until it was in tatters. On September 18, 1992, a tersely worded, single-page "Memorandum for Correspondents" announcing the "declassification of the existence of the National Reconnaissance Office" was issued by the Department of Defense: "There is a National Reconnaissance Office...," it read. Two and a half years later, President Clinton signed an order declassifying Corona, which had flown the last of its 145 missions on May 25, 1972.

In 12 years of operation, the satellites had sent down 167 film capsules with more than two million feet of film—some 800,000 pictures. A party of sorts to celebrate Corona's public unveiling was held at the National Air and Space Museum in Washington on May 24, 1995. One of the host sponsors was the NRO.

Coming in from the cold required substantial adjustment by the NRO, some of it discomfiting to its veteran shadow people. With the need for the organization's activities greatly reduced, its estimated $6 billion annual budget (larger than the CIA's) began shrinking. Then, in 1994, the *Washington Post* reported that the NRO was abandoning its lair in the Pentagon for luxurious new $300 million digs in Chantilly, Virginia, almost 30 miles from Washington. The four crisp, slate-blue, glass-and-steel buildings off Lee Road could pass for an upscale corporate headquarters. A year later, Congress went into an uproar when the *Post* reported that the NRO was "hoarding" more than $1 billion in unspent satellite funds.

It was an unfair hit. Spy satellites'

lifetimes, and therefore replacement rates, are determined by how much fuel they use and by their ability to generate electrical power. With the cold war at an end, the requirement to maneuver was reduced, so the satellites used less fuel and therefore lasted longer. That meant fewer replacements had to be launched and unspent money accumulated. Then, in June 1996, it was disclosed that the NRO had "lost track" of more than $2 billion ("more than the annual operating budget of the State Department," *The New York Times* reported). It was all enough to make the old hands long for their collective cloak.

Left unreported was the fact that the NRO had worked its way out of the old system. After the breakup of the former Soviet Union, programs A, B, and C were combined into a single group. Borrowing a page from Darwin—adapt or die—the NRO joined the CIA in trying to adjust to a world without a Soviet Union. As it had once embraced absolute secrecy, it now resorted to the intelligence world's most disagreeable activity: PR. It opened an Office of Corporate Communications, sent speakers to talk to students at the nearby Cub Run Elementary School, and even started a Web site (www.nro.odci.gov). In this, it joined the CIA, whose own Web site (www.odci.gov/cia) even has a "Kid's Secret Zone."


NRO

Recently published brochures note that technology developed by the NRO has led to high-definition television, mammography screening for breast cancer, and other innovations. The new NRO said it wanted "partnerships with customers and industry" and started shopping for them. Today the National Reconnaissance Office has a new clientele, new products, and a new set of rules that enable it to use information from satellite imagery to assist federal agencies. Assessing natural disasters for relief operations, identifying toxic waste sites, monitoring oil spills, surveying land use, mapping difficult terrain, and monitoring mining operations are all ways the NRO has recently used its spy satellites as Earth monitors. Richard Bissell, who died in 1994, had practiced economics before he practiced espionage. He undoubtedly would have nodded and smiled approvingly.

## Future Shock

Not everyone at the NRO believes in the new world order. Former CIA director James Woolsey's warning that the dead Soviet dragon has been replaced by a garden of poisonous snakes is taken as gospel, as is the notion that the dragon may not be dead. So what will the United States need to know into the 21st century?

Although the need to collect technical intelligence remains—monitoring missile tests in North Korea, for example—the new threat is moving, spreading, and becoming more devious. Terrorism and cyberwarfare, or information warfare, are high on the list of dangers over the horizon. In a new project called 20/20, the NRO is drawing on experts in academe and industry to predict what the world will look like 20 years hence. The idea is to create as clear a picture as possible not of mere trends but of new threats so that countermeasures can be readied.

New systems and spacecraft are needed. The Future Imagery Architecture (FIA) program will make real-time imagery available to military forces in combat. The challenge is to get pictures to the troops and filter out all the irrelevant data. That's the responsibility of the new National Imagery and Mapping Agency. And as the threat changes, the satellites will have to operate in new and different orbits.

An Integrated Overhead Sigint Architecture program is the signals intelligence equivalent of the imagery program. It will intercept communication between terrorist cells, pull in telemetry from ballistic missile test programs, and provide warning of nuclear tests. If the NRO's Directorate of Signals Intelligence doesn't have the right spacecraft (a Rhyolite successor, for example), then the Directorate of Advanced Science and Technology has to dream one up and ask potential contractors to submit proposals.

Thanks to dramatic advances in miniaturization, the imaging satellites themselves will become smaller, which will make them cheaper to build and to launch. The laws of physics will remain immutable: No high-resolution close-look telescope is going to fly in a package the size of a wastebasket. And since imaging satellites last only as long as their maneuvering fuel, it seems certain that new ways of changing their orbits, including the use of tiny ion thrusters, are under study.

It also seems certain that satellites are going to have upgraded infrared capability, high-definition radar for night and all-weather imaging, and the ability to stare at one spot. A telescope staring at a place on Earth from 22,300 miles out would have far better resolution than one on Earth looking 22,300 miles in the opposite direction. That's because of the "bottom of the ocean effect": There is far more distortion looking up at the world from the bottom of a swimming pool than there is looking at the bottom of the pool from a diving board. Staring at one place for days or weeks is not farfetched. A Hubble Space Telescope-sized optical system, looking down instead of out, should be able to do the job. The Hubble uses the same basic optics as its NRO cousins, Hexagon (or "Big Bird"—the KH-9) and Crystal, the old KH-11. All three satellites were sired by Lockheed Missiles and Space Company. Perhaps the most telling sign that things have changed was the surprising award in early September of the FIA contract to Boeing, thereby ending a relationship with Lockheed that dated back to 1958. One reason cited for switching to Boeing was the need to contain costs. And civilian satellites with three-foot resolution offer the promise of round-the-clock satellite service to all potential users—like a kind of public utility. The NRO, for one, will never be the same.

# A FLIGHT ALONG AMERICA'S HIGHWAY

## One man's mid-century portrait of the United States—from 1,500 feet.

by John Fleischman *Photographs by William A. Price*

ROBERT BEDELL

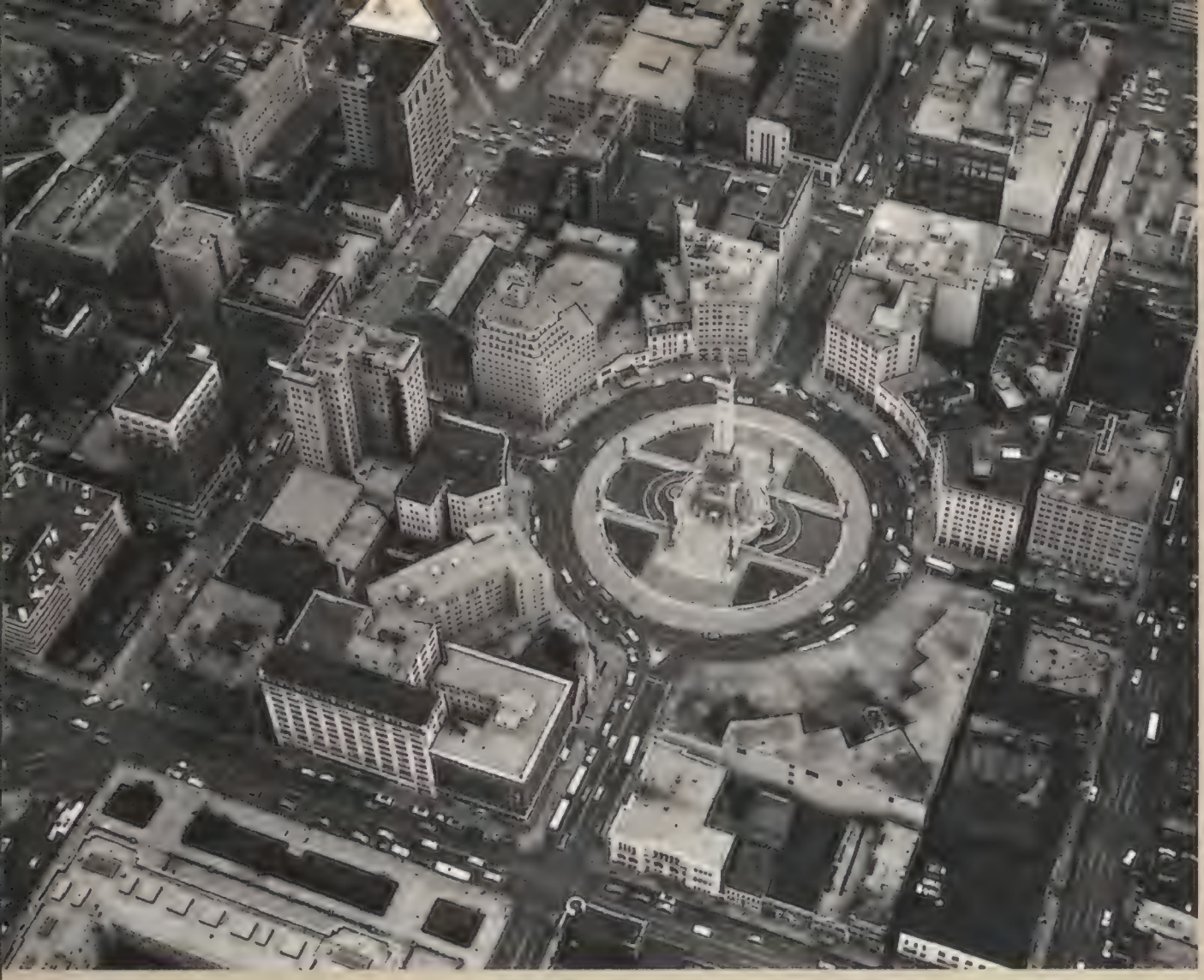
In the decade or so after the end of World War II, whole fleets of perfectly good but obsolete aircraft were surplussed by the U.S. military and fell into the hands of a generation of ex-military pilots. Some vets wanted to start airlines or crop-dusting services. Some just wanted to fly for the pleasure of it. Bill Price wanted to take an aerial portrait of the United States. He proposed buying a surplus airplane and buzzing America's Main Street, U.S. Highway 40, capturing its likeness with a camera.

Price believed that a low-altitude aerial survey would reveal patterns in geology, agriculture, housing, industry, and American culture that were invisible on the ground. "I was trying to figure how it would be possible to take a sample of the whole country all the way across, but it needed something to hold it together and Highway 40 seemed the way to do it," he says. Price planned to make a book of it, a collection of handsome plates with a detailed analysis of what he saw along U.S. 40, which stretched from sea to shining sea.

The plan began in 1945 when Price was declared war surplus himself. He was discharged from the U.S. Navy at 30 as a full lieutenant (senior grade). He had racked up over 2,300 hours tooling around the northern and central Pacific in PBY Catalinas and PBM Mariners, twin-engine amphibious patrol bombers, and all that flying time left him quite at ease in a cockpit.

Upon discharge, he went to work at his last place of civilian employment, the newsroom of the *New York Daily News*, where he had to work as a copy boy before returning to the rank of reporter. Soon he was able to convince the paper that it needed its own air force, a Waco biplane that he ferried in from Troy, Ohio, and operated from a grass strip in Queens, just across the East River from

*It was the summer of 1954 when Bill Price, flying a World War II-surplus observation airplane, made a coast-to-coast journey along U.S. Highway 40. Price shot hundreds of images with a K-20 aerial camera (above), including the one at right, in which the highway detours around a farmer's field near Martinsville, Illinois.*



*Flying at various altitudes, Price captured the many textures of 1950s America: downtown Indianapolis (top), a steam-powered train chugging through farmland (above), a nearly treeless housing development in suburban Maryland (right), and eroded soil in the foothills of Colorado's Rockies (opposite).*

Manhattan. Price was soon flying *News* photographers over horse races, outdoor ceremonies, fleet reviews, ocean-liner arrivals, and plane crashes. Price thought the camera work didn't look that difficult, so he bought himself an Argus C-3, which he used in freelance work for aviation magazines.

He'd already bought his own airplane, a U.S. Army Air Forces Stinson L-5 with a Lycoming engine. Price had picked it up in December 1945 for a song in Muskogee, Oklahoma, and for the next few years he flew it hard and everywhere in the eastern United States. He then took a leave of absence from the *Daily News* and set out in January 1948 on an odyssey south to Texas ("Feb. 4, 1948, Stimson Field, San Antonio—STINKO WEATHER") and on through Mexico, Guatemala, Honduras, Nicaragua, and Panama, where he had a buyer waiting. The last leg was the hairiest; in Colobre, Panama, he joined an air search over the jungle for a missing pilot (who turned up safe elsewhere), and his log then tracks him from Paitilla Airport to remote "Pinogana Village to pick up boy with tetanus infection and returned to Paitilla and hospital—strip 650′ long, 12′ wide—mountain one end, trees other—no wind—boy's mother had to come—big gal & pregnant to boot—barely cleared trees, landed Paitilla with 3 gals. gas left—boy died in hospital 1 1/2 hours later." When he sold his L-5 in Panama City, Price had accumulated nearly 300 hours of civilian flying. And soon after, he had a pair of war-surplus K-20 Fairchilds, aerial cameras that produced four-by-five-inch negatives in rolls of 50.

After he sold the L-5, Price flew rented and borrowed aircraft: a Ryan trainer, a Piper J-3, and an amphibious Republic Seabee. In February 1951, he rented a Cessna 120 at the Linden, New Jersey airport and hopped west, visiting old friends and throwing the side window open in the frigid air to take aerials. He figured out how to handle the stick with his knees while photographing steam locomotives or his airplane's shadow flitting across cornfields. He turned for home from St. Louis on March 1, and en route to Gary, Indiana, flew over the county seat town of Carlinville, Illinois. And there, a few

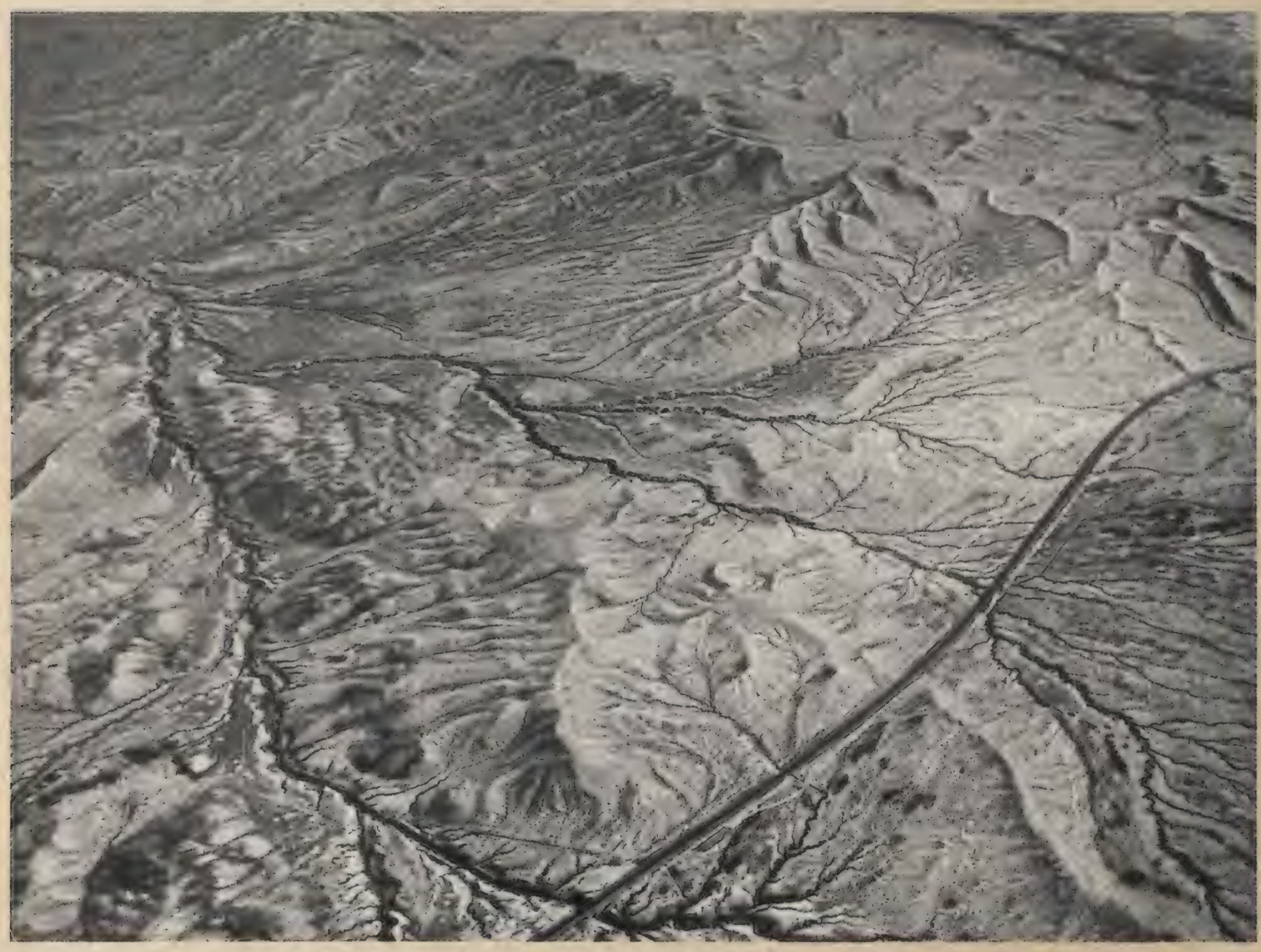
hundred feet above the domed courthouse, Bill Price discovered what he called "the synoptic eye."

Three years later, while he was on his flight along Route 40 with his friend Bob Bedell, Price was still thinking about the synoptic eye. He explained it to Bedell and two nurses in a Cincinnati night spot one evening. Price spread the aerial photo of Carlinville that he'd taken in 1951 out on a table. In the center was the courthouse and around the grassy square were the pillars of a mid-century, Midwestern town—a block of stores, a block of churches, a block of rooming houses and apartments, and on the far side of the square, a row of substantial private homes, dominated by a large Cape Cod with a screened breezeway and a fenced yard.

Bedell, who is today a globe-trotting engineering consultant, was in 1954 an engineering professor on summer vacation from New York's Cooper Union when he signed on as Price's assistant for the flyover. In Cincinnati, Price and Bedell were a good 70 miles south of U.S. 40, but they were there because Price wanted to look up the two nurses, whom he'd met on an earlier trip.

Looking back over 45 summers, Bedell remembers the evening clearly. "Bill had this picture with him and he was saying the airplane gives you the 'synoptic eye,' the ability to sum things up from the air," he remembers. "And he says, 'My guess is that the woman who lives in [the Cape Cod] house reads the *New York Times*. And [the nurses] say, 'Ah, you're crazy, Bill.' So we made a bet. It was for two cartons of cigarettes or they would have to take us both out to dinner, but the deal was that we couldn't ask a direct question. We had to knock on this woman's door and find out without asking her directly. So we detoured at Alton and went up to Carlinville. We knock on the door and this woman says, 'Sorry, you can't come in.' She thought we were trying to sell her an aerial photo of her house. But we talk and talk and talk and finally she lets us in. We start asking her questions like 'What do you do?' She says, 'I'm a nurse. My training was in St. Louis but I lived in New York for a while.' So we go on asking questions and finally we say, 'What do you read?' And she says she reads this or that magazine, 'but every time I get to St. Louis, I buy a copy of the *New York Times*.' "

So how did Price do it? Sitting in his apartment on Manhattan's Upper West Side, Price, now 84, laughs at his own cockiness. It is a hot spring day, and through the open windows come am-



*On August 25, Price photographed an automobile dump east of Salina, Kansas (above). The next day, an overheated engine forced him and Bob Bedell to land in a wheat field near WaKeeney, Kansas, where Officer George Valentine (standing in front of his police car with Bedell) summoned a mechanic to fix the L-13.*

bulance sirens and car horns. Price's living room is jammed with second-hand furniture, photo albums, books, filing cabinets, artwork, pictures of himself as a handsome young Navy flier, left-wing political posters, a stereo, and, over in the corner, a wooden airplane propeller. Also present is Bedell and an old friend of Price and Bedell, Jane Hogg, who comes into the synoptic eye story a little later.

The three friends are gathered at

Price's apartment to make sense of the yellowing notes and curling contact prints from all those years ago and to hear Price explain his Carlinville caper of spotting the *Times* reader from 1,500 feet. "I was always trying to find the clues you could see from the air," he says. "Here this is the county courthouse so this is obviously the town center. Now on this side are the well-to-do. These are pretty big houses, substantial homes, but this one is different. It's in a New England style and it's the only one with a fence around it. It has the only fence in the whole picture so I thought this would indicate someone who read the *New York Times* in the middle of nowhere."

That was the theory—that an aerial viewpoint inspires speculations about life on the ground. The means for testing it was Price's second war-surplus airplane, a Consolidated Vultee L-13. He bid on it through the mail, and the government said it was his for $2,000. In June 1954, he dragged Bedell, who was not a pilot, down to Panama City, Florida, where they took delivery. The L-13 came in bare metal, a tail-dragger with a Franklin 245-horsepower engine and a two-seat, side-by-side, glass-covered cockpit. Its big fold-down side windows made it perfect for flying a camera. The L-13 also had radios, though it wasn't supposed to. "Whoop-dee-doo," said Price when he spotted them.

Price and Bedell took off on August 18, 1954, from Pennsville, a tiny airfield in southern New Jersey, crossed the Delaware River, and turned west to follow U.S. 40 as far as daylight and weather allowed each day. The synoptic eye was airborne.

Looking back at those pictures now, one sees the country alternate between an old-fashioned appearance and an extremely modern one within the space of a few frames. Price photographed a new housing tract just west of Elkton, Maryland, part of the post-war era of sprawling suburbs that still swallow up farmland at an alarming rate. An hour's flight west and he was over untrammeled farm country, photographing a landscape of fields to the horizon, all contour plowed and planted.

The highways and streets in 1954 still belonged to big American cars, with not an SUV, mini-van, or VW bug in sight. Though U.S. 40 was two lanes of serviceable concrete, the interstate highway system was already under construction. Within a decade, interstates would consume long segments of U.S. 40, and the route would be incorporated into I-70 or I-80. Elsewhere, the interstates would simply bypass U.S. 40, leaving the towns that lived off its passing traffic to wither.

On their journey, the fliers found a more trusting hospitality than they probably would encounter today. From Indianapolis they flew west to Alton, Illinois, then north to Carlinville to interview the woman who lived in the Cape Cod house. There was no airport so they had to set down on a farmer's private strip. Bedell remembers: "This guy comes out in his truck and says, 'What's up, boys?' So we explain about what we were up to and he says—and this was a Saturday night—he says, 'Just make sure you have the truck back on Monday morning because I'll need it.' It was incredible."

Jane Hogg agrees. She flew much the same route with Bill Price a year later to fill in areas of the country that Price felt he hadn't adequately captured. "People were amazingly generous," she says. "You'd fly into an airport and someone would say, 'Do you need a lift into town? I'm going that way and I'll take you.' Maybe it was the pilots' fraternity, but people had a different attitude towards small planes then. I still remember circling Zanesville, [Ohio], in the dark, trying to figure out where the airport could be. We circled the field a couple of times until I realized that there were a lot of cars driving toward the airport. They knew the

*More than three years before he began the Highway 40 flyover with Bedell, Price photographed the domed courthouse of Carlinville, Illinois. To the right of the courthouse is a fenced Cape Cod house, whose occupant Price predicted read the* New York Times. *Price attributed such aerial insight to "the synoptic eye."*

sound of a plane in trouble. People circled the field with their lights on."

Even if they hadn't, Price probably wouldn't have broken a sweat. Nothing seemed to bother him in the air. There was the time, Hogg says, when Price flew them along the front edge of an electrical storm. "I remember asking him what would happen if the plane was struck by lightning," she says. "And he said, 'Don't worry. The plane's insured.' That was not the response I wanted." Price grins.

Once he and Bedell had to make a forced landing. Flying over WaKeeney, Kansas, their engine overheated. "We had the tech manual; it was the size of the Manhattan phone book," says Bedell. "I looked it up and said, 'Bill, the head temperature is going up. We've got to land right away.' And Bill said, 'Those instruments are never right.' So I handed him the manual and he handed it right back and said, 'Oh, you're serious.' So he put it down. The landing we made was exactly 37 feet. We measured it. It was 37 feet from touchdown to stop." Price climbed out to photograph the silver L-13 in a stubbled field. Bedell duly noted in the photograph log that he was keeping the arrival of Officer George Valentine of the WaKeeney Police Department, who summoned a mechanic.

Their airplane repaired, they headed west toward the Colorado Rockies, following U.S. 40 across the high country to Vernal, Utah, then along the Salt Lake and on to Elko, then Reno, Nevada. Now the land opened up as wide as a K-20 camera could see. Price snapped dry rivers that looked like roads and shiny roads that looked like rivers. They went over Donner Pass with 3,000 feet to spare and swooped down the Pacific slope to Sacramento. At 4:45 p.m. on September 10, the synoptic eye circled the Golden Gate Bridge, firing the K-20s. With weather layovers, emergency landings, and detours, it had taken 24 days and 938 exposures to run Bill Price's traverse.

At that point the synoptic eye lost some of its focus. Bedell stayed in California to visit family. Price flew the L-13 to Phoenix, Arizona, where he

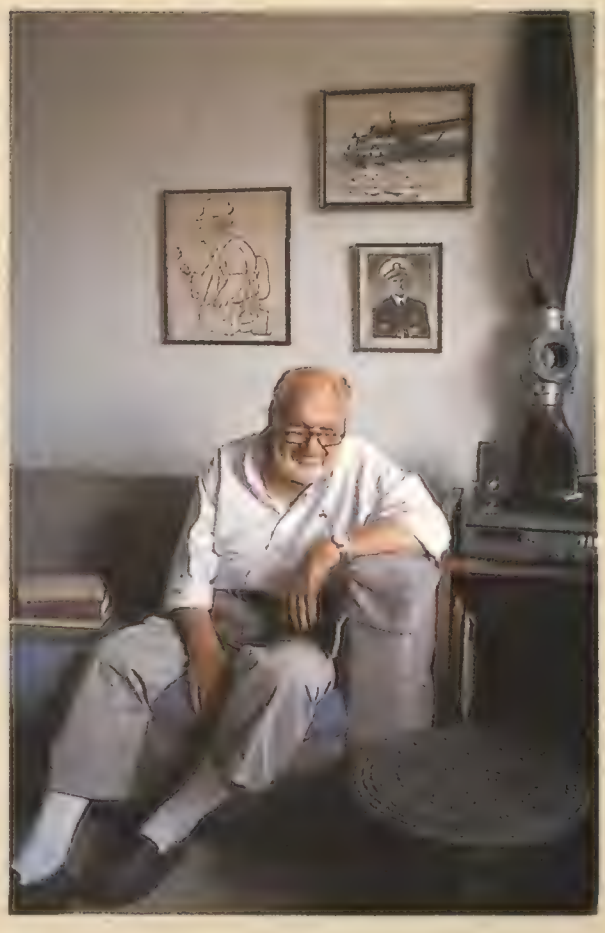
*On a solo trip prior to the journey with Bedell, Price practiced using the K-20 camera. Somewhere in the Midwest, he captured his airplane's shadow over a pair of railroad tracks.*

*Price and Bedell ended their flight along Highway 40 with a view of San Francisco's Golden Gate Bridge from 3,700 feet.*

*Though Price (below, flanked by a photo of himself as a Navy pilot and the propeller from his Stinson L-5) never published his book about the Highway 40 trips, he treasures the images—and memories—he gathered along the way.*

sold it for $10,000 and took a commercial flight back to New York. But even with the profit from the sale of his airplane, Price was struggling to complete his project. He was finding the late 1950s a time of increasing hostility toward his brand of progressive politics. His cousin, CBS news correspondent George Polk, had been killed under suspicious circumstances while reporting on Greece's civil war in 1948, and Price became active in a newsmen's commission to investigate the extent of CIA involvement in Polk's murder. That and Congressional investigators convinced the *Daily News* to drop him. Price moved into a second career as a purely political journalist, community organizer, and chronicler of housing wars in New York City.

He bought one more surplus airplane, another Stinson L-5. That's the craft he convinced 19-year-old Jane Hogg to climb aboard in 1955 to serve as his note taker on the fill-in trip. They set out west on September 22, 1955. The weather was beastly. It took three days to fly from Moorestown, New Jersey, to Newark, Ohio. "We could have driven it faster," laments Hogg. The pace picked up after that, but the return journey was more of the same. "On the way home, I couldn't take the length of the trip," says Hogg. "Finally we'd put down again in somebody's back



CAROLINE SHEEN

yard somewhere between Philadelphia and New York and I said, 'That's it. I'm just going home by bus.' " It took Price another two days to get the L-5 back to New Jersey.

The 1955 expedition lasted 18 days, including weather layovers, and went no farther west than Kansas. Still, Price filled in his portrait of U.S. 40 from Atlantic City to Baltimore and missing links in Ohio, Illinois, and Missouri.

Later that fall, Price realized he could no longer afford to keep his own airplane. Tie-down fees, repairs, and maintenance made it too expensive a luxury, forcing him to sell the L-5. He never piloted an airplane after that. He did, however, keep the L-5's old prop, which has served as part of his home decor ever since. He never could find a publisher interested in the monumental volume that would be required to do the synoptic eye justice. For decades, the only people who explored his albums of prints were family and friends. In 1994, his apartment was heavily damaged by water in the aftermath of a fire. Virtually all of his meticulously catalogued negatives were destroyed. The contact sheet albums and several boxes of prints are all that's left of his transits of America. That and the stories.

Why did he persist with this private photographic expedition? Why did he go into hock and risk his neck over and over to photograph alluvial fans in the Sacramento Delta and a junkyard near Russell, Kansas? "I've been trying to figure that out myself," says Price. "It's obviously a question that I ought to have an answer for. I think it's something like, I'm in love with America. I know that sounds kind of crazy 'cause I'm very critical of what the U.S. is doing these days, but get away from the cities and the political centers, then you can see the land and what kind of impact we've had on everything. It's a very strong thing. I found myself thinking of two songs. The first is 'America, the Beautiful,' which is not a political song, and then comes Woody Guthrie's 'This Land Is Your Land.' "

From the redwood forest to Pennsville, New Jersey, at 2,000 feet and 115 miles per hour, this land was made for you and me and Bill Price.

For more of Bill Price's U.S. Highway 40 collection, visit the Web at www.airspacemag.com

The truism that air transportation has made the world a smaller place is nowhere more evident than at airports, where margins are frequently tight in time as well as space. At Paris' Charles de Gaulle Airport, French photographer Etienne de Malglaive captured the fast-paced operations by camping out near a runway. He caught an Air France 737-200 as it waited for a 747-200 from the same airline to land on a runway that crossed its path (below). "De Gaulle has many routes that all lead to one point, so you don't have the same huge lines like at Kennedy [International Airport]," Malglaive says. "So it's hard to make pictures of traffic. But I got lucky."

London-based photographer Mark Wagner sought a higher perspective for his dramatic image of a Cathay Pacific 747-300 roaring out of Hong Kong's intensely urban Kai Tak airport in 1996. Wagner climbed one of the city's many steep mountains to get the view at right. "I thought it was just an amazing backdrop, with all those apartments," he recalls. "It just says everything, really, about urbanization and mass transport."

Now closed, the airport had a reputation among pilots as one of the most challenging to approach and depart from. "To see massive wide-body jets turning so steeply on final approach was thrilling," Wagner says. Kai Tak closed in 1998 to the disappointment of its many fans—and the traffic shifted to the new Hong Kong International Airport, about 20 miles west.

## ▶SIGHTINGS◀

MARK WAGNER

ETIENNE DE MALGLAIVE


ATHAY PACIFIC

# Hollywood Sees Red

## Mission to Mars

*Touchstone Pictures. Scheduled release: March 3, 2000.*

ROB McEWAN

The year is 2020 and all systems are go for the first manned mission to Mars. Astronaut Jim McConnell had been chosen to be the first man to walk on the Red Planet. Personal tragedy ended that dream, so Luke Graham assumed the honor and the commander's seat.

Shortly after Mars One arrives, Graham and crew discover something strange in the Cydonia region—not the infamous face (which turned out to be nothing more than shadows on a hilltop) but another, very unnatural-looking mountain. They fire a radar signal into the 800-foot-high anomalous structure. And then, all hell—in the form of an alien vortex—breaks loose. When the red dust settles, the only astronaut left alive is Graham. The habitat base has been ravaged and all communication systems destroyed. At mission control, NASA knows only that disaster has struck.

Although the real NASA has no manned Mars mission on the boards yet, the prospects for sending humans to the Red Planet are looming large in Tinsel Town. In fact, boosted no doubt by the phenomenal public response to the Mars Pathfinder rover, Hollywood will be launching no fewer than four trips to the fourth planet in the next year and a half. *Mission to Mars* is the first to blast off.

In Hollywood high-concept jargon, *Mission to Mars* could be described as "*Die Hard* meets *2001: A Space Odyssey* on a *Close Encounters of the Third Kind* level." The film's producer, Tom Jacobson, who boasts an engineering degree in addition to development and production credits that include *Independence Day*, describes it as "a dramatically realistic adventure story about human space flight in the near future, coupled with a speculative idea of what we might find."

A big-budget production—just under $100 million, according to Jacobson—*Mission to Mars* is banking on its scientific realism, character-driven storyline, and the talents of director Brian De Palma and actors Gary Sinise and Tim Robbins to rocket it into history as the first blockbuster of the new millennium.

"We're trying to make it like NASA would...basically," says De Palma. Indeed, the film, which garnered the full support of the space agency, had no shortage of consultants. Among them: astronauts Story Musgrave and Joe Allen; Matt Golombek, chief scientist for the Mars Pathfinder; Kathy Clarke, chief scientist for the international space station; and Robert Zubrin, former Martin Marietta senior engineer, Mars Society founder and president, and author of the book *The Case For Mars* (the rights to which were purchased for *Mission to Mars*). "We took the basic ideas of what the spaceships and habitats on Mars would look like, based on NASA's designs, and extrapolated with a little bit of Hollywood sizzle," Jacobson says.

"I'm amazed at the level of detail, right down to these little rivets," Musgrave says as he walks through the Mars habitat on the Vancouver soundstage. He adds: "I would like people to be able to sit in this command module and experience the spirit of spaceflight the way I do." He's working to convince Disney to make that happen by transforming the set into a permanent attraction.

The exterior shots will be impressive too, courtesy of a 55-acre Martian

RE-RELEASED

### To Fly and Fight


*by Colonel C.E. "Bud" Anderson with Joseph P. Hamelin. Pacifica Press, 1999. 302 pp., $29.95 (hardcover).*

Well-known World War II memoir. Autographed copies are available from www.cebudanderson.com.

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landscape created at the Fraser Sand Dunes, about 20 miles south of Vancouver. Once the dunes were sculpted with bulldozers and covered with lava rock, they were fire-hosed with 120,000 gallons of "Martian Red" latex paint, with the skies to be filled in later with special effects created by Industrial Light & Magic and Disney's Dream Quest. Additional landscape shots were created by using various real images of Mars blended with digital maps of locations in the Canary Islands and southern Jordan to create an otherworldly look.

In this fictional scenario, NASA decides—although there is no way of knowing that Graham, played by Don Cheadle, is still alive—to send a recovery mission. Woody Blake (Tim Robbins) becomes the mission commander, with McConnell (Gary Sinise) as copilot and Terri Fisher (Connie Nielsen), who also happens to be Blake's wife, and Phil Ohlmyer (Jerry O'Connell) as mission specialists. There is certainly no shortage of action. If the devastation wreaked by the alien vortex wasn't enough, the Mars recovery spaceship encounters more tragedy and the astronauts are forced to abandon ship in open space, taking refuge on REMO, a resupply module that originally was to have been called down to the surface by the Mars One mission. "There is more drama than you would like on a Mars mission," says Musgrave, who was initially brought on for a week but wound up a permanent fixture on the set and landed a cameo role. "You would not want this many things happening."

Interspersed among the action sequences are more ethereal scenes, including a romantic zero-G dance with the Blakes floating gracefully to the tune of the popular classic "Blue Moon."

Science, action, and romance aside, *Mission to Mars* is "a movie about exploration and internal exploration, examination of the self and human growth—the human quest," says Musgrave, who ultimately defined his role as getting the actors' heads and hearts "where they would be" in any given part of the mission.

The movie illustrates science colliding with the spiritual, and "something pretty miraculous is revealed about what it [the vortex] actually was, and why it was defensive at the beginning of the movie, yet embracing and transcendental at the end," Jacobson says, and then adds, "if our music works well."

Meanwhile, *Titanic* director and self-proclaimed "Mars wacko" James Cameron is co-writing and producing a five-hour miniseries based on his original story about the first manned mission to Mars. Parts of the miniseries will also be integrated into a 3-D IMAX film, which he is co-directing. Both projects are slated for release in the summer of 2001.

Still another film, *The Red Planet*, is due out from Warner Brothers shortly after *Mission to Mars*' March 2000 release. It revolves around the premise that Earth has become a dying planet and a new Mars colony is humanity's only hope for survival.

Mars, more than ever before, is in the *Zeitgeist*. As Golombek puts it: "Mars is special because of the question of life." Until a real manned mission is scheduled, at least you can don your spacesuit and head to the movies.

*—A.J.S. Rayl is a Malibu, California-based freelance writer who covers science, technology, and pop culture.*

ON TELEVISION

### Space Station

*Two-part documentary airing on Tuesday, December 14 and Tuesday, December 21 at 8:00 EST on PBS.*

NASA

Episode one examines how the international space station's components are being assembled worldwide. Episode two covers the mating for the first two modules.

### If We Had No Moon; Our Savage Sun

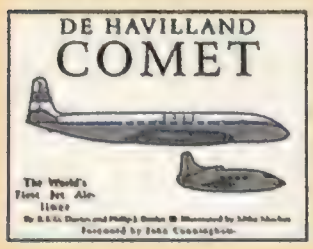
*Back-to-back premieres on December 6, 1999, 8:00 p.m. EST and 9:00 EST on Discovery Channel.*

Two specials examine the effects of the sun and moon (which is gradually moving farther away from Earth) on tides, the length of the day, radio transmissions, and even the electrical grid that powers your television.

COLORFUL COMETS

### De Havilland Comet: The World's First Jet Airliner

*by R.E.G. Davies and Philip J. Birtles, illustrated by Mike Machat. Paladwr Press, 1999. 64 pp., $30.00 (hardcover).*




The latest book from NASM curator and airline expert Ron Davies includes a detailed history of the Comet's development and colorful illustrations of the aircraft in various liveries.

## Low and Slow: A Personal History of a Liaison Pilot in World War II

*by Don Moore. San Antonio Heights Publishing Co. (PO Box 571, Upland CA 91785), 1999. 234 pp., $20.00 including shipping and handling (paperback).*


The title comes from the mother who urged: "Son, be careful; fly low and slow." Low and slow is where a military pilot doesn't want to be, but it's where a U.S. Army artillery spotter had to spend his time. Don Moore is quick to point out that the hazards of flying 800 feet above the Philippines paled in comparison to combat on the ground: War is hell, but his war was "more funky than demonic."

Moore once had a dogfight with a Mitsubishi A6M Zero: two cannon and two machine guns versus a Piper Cub armed with only a carbine. As long as the airplanes were closely entwined, Moore had the upper hand, since he could turn inside the Japanese fighter. Then the Zero moved off, setting up for a fast attack that the 65-horsepower Cub couldn't have dodged. Moore dived for home, and he and his rear-seat "gunner" were out of the Cub and into a trench before the Zero passed over.

More terrifying, actually, was the time he was sucked into a cloud. Anti-aircraft guns were popping off beneath him, U.S. bombers were roaring through the cloud beside him, and Moore had to fly on instruments with only a compass, tachometer, airspeed indicator, and altimeter. Against all logic, he made it home that time as well. Still, as his commander warned him, the odds didn't favor a liaison pilot: "All you have to do is fly one of these things long enough, and it will get you."

When Moore doesn't remember the details, he says so. The effect is like listening to a favorite uncle entertaining his nephews with an old adventure so extraordinary that he still can't quite believe that he took part in it.

A delightful book.

*—Daniel Ford flies a Piper Cub out of Hampton Airport, New Hampshire, generally staying above 2,000 feet.*

## Three Other-Worldly Books

**Journey Beyond Selene: Remarkable Expeditions Past Our Moon and to the Ends of the Solar System** *by Jeffrey Kluger. Simon & Schuster, 1999. 384 pp., $26.00 (hardcover).*

**Worlds Without End: The Exploration of Planets Known and Unknown** *by John S. Lewis. Perseus Books, 1998. 236 pp., $13.00 (hardcover).*

**Our Worlds: The Magnetism and Thrill of Planetary Exploration** *by S. Alan Stern. Cambridge University Press, 1999. 172 pp., $54.95 (hardcover).*

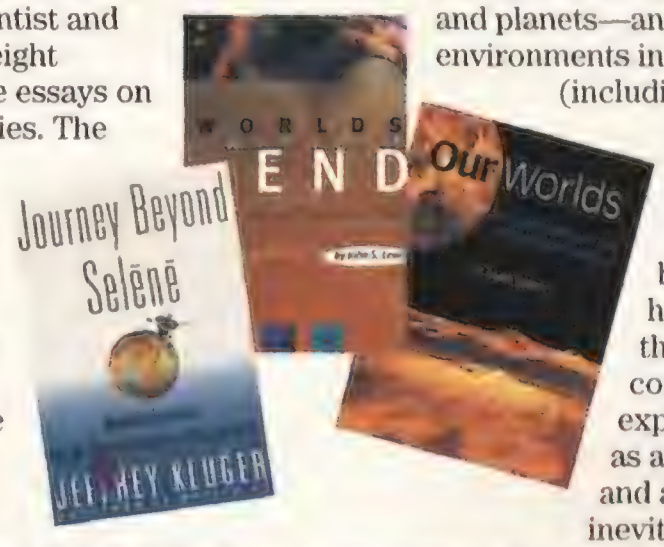
Exploration of the heavens with automated spacecraft is today a boom enterprise. Reports from the space front—in our home solar system or from galaxies far far away—are a regular feature of the news and science programming on television. Once a less popular sibling of human exploration initiatives, space science now shines clearly in the public eye.

The reasons for this are several. Since the late 1980s, the pace of science exploration and the flow of new data, broadening our knowledge and testing theories, have been unprecedented. The Voyager flybys of the outer planets, the Hubble Space Telescope, Mars exploration, and new observatories such as the Chandra X-ray telescope have reinvigorated planetary and astronomical study and their public appreciation. And not least, NASA and the science community have been effective promoters of these exciting developments.

But enthusiasm for this research also stems from a nifty conceptual turn. In recent years big questions about the nature of the universe have merged with examinations of the origins of life. Studies of Mars, Jupiter's moon Europa, planets around distant suns, the birth of solar systems and galaxies, and the Big Bang find their measure in what they may tell us about our own origins and future. Science initiatives, seem, in the last days of the millennium, to amplify the call for a human destiny in space.

Jeffrey Kluger, co-author of *Lost Moon*, the acclaimed account of Apollo 13, invites us to see our history of solar system exploration as a continuum of human and science missions in *Journey Beyond Selene: Remarkable Expeditions Past Our Moon and to the Ends of the Solar System.* His account covers the first robotic probes to the moon in the 1960s, the Apollo expeditions, and explorations of the outer planets by Voyager and of Jupiter by Galileo. The human and emotional dimensions of these explorations—not their science or history—are the author's focus. Kluger takes us into the world of scientists and engineers associated with these missions, most of whom call NASA's Jet Propulsion Laboratory home. We glimpse their day-to-day routines, frustrations (particularly when individual creativity inevitably collides with bureaucracy), and moments of triumph. They emerge (as Kluger intended) as a special breed of explorers, as plucky and talented in their own way as the more heralded astronauts.

This theme of scientist as passionate space explorer also inspires S. Alan Stern's *Our Worlds: The Magnetism and Thrill of Planetary Exploration.* Stern, a planetary scientist and astrophysicist, asked eight scientists to contribute essays on their research specialties. The novelty of this volume is Stern's criteria for selecting authors. Each demonstrates a career-long dedication to the study of a particular object in the solar system and is "second generation"—that is, trained by top scientists (such as Harold Urey and Carl Sagan) who inaugurated space-based planetary research. The perspective is that of seasoned researchers, still in their prime and looking ahead to new challenges. Again, as in Kluger's book, the focus is on a scientist's personal quest and the emotional satisfactions of research, inviting us to identify with the scientist-explorers. Within this format, the essays describe research on Mars, Venus, the moon, asteroids, Comet Halley, Io, Titan, and Triton.




The aforementioned books seek (engagingly but sometimes too earnestly) to expand our appreciation of the ranks of space explorers. In *Worlds Without End: The Exploration of Planets Known and Unknown*, John Lewis, a professor at the University of Arizona, turns the telescope back toward the heavens and contemplates the possibilities of life on planets and moons in our own solar system and elsewhere. His presentation is spurred by two recent discoveries: bacteria that thrive in environments once thought to be too hostile to support life and confirmation that planets circle stars other than the sun.

These developments suggest life, at least in rudimentary forms, may be present elsewhere in the universe. The heart of the book is a vigorous, probing analysis of the factors affecting the creation of solar systems and the formation and evolution of planets. Factors determining a planet's environment include type of and distance from parent star, material composition, mass, temperature, geometry of orbit, and cosmic accidents such as collisions.

Slight changes in any of these variables can result in very different outcomes. For example, if the mass of Earth was somewhat less or more (all other factors remaining constant), the planet would look quite different. Small Earth would be dry and barren like Mars; large Earth would be completely covered by water—changes yielding very different possibilities for life. By the end of Lewis' thorough but playful analysis, the reader has gained an appreciation of the subtle and dynamic life of solar systems and planets—and the range of environments in which life (including possible non-carbon-based organisms) might arise.

All of these books convey the hard, clever work that enlivens contemporary space exploration, as well as a fervid optimism and a sense of inevitability in our exploration of the planets. Their heroes are the vanguard, claiming that we can no longer be inward-looking, Earthbound isolationists. At the turn of the millennium, who can resist this appealing mix of discovery and yearning?
*—Martin Collins is a space history curator at the National Air and Space Museum.*

## Tales of a War Pilot

*by Richard C. Kirkland. Smithsonian Institution Press, 1999. 160 pp., $21.95 (hardcover).*


Mainly because of contrived dialogue, *Tales of a War Pilot* fails to achieve the literary aim stated in its introduction—to relay war stories and "describe the human side of it all"—but Richard Kirkland's stories are interesting by virtue of their content. During World War II, Kirkland flew P-38 Lightnings on the wing of such famous pilots as the highly decorated "ace of aces" Major Richard Bong and icon Charles Lindbergh—who demonstrated a new fuel saving technique to Kirkland's squadron. Kirkland was assigned to watch over Lindbergh during combat missions but found that the Lone Eagle flew a Lightning "like he'd been born in it."

## REVIEWS & PREVIEWS

The sheer amount of such interesting stories makes up for repetitive writing, including the multiple use of the phrase "remarkable events in human history."

The book is broken into 11 short segments, relaying the adventures of both Kirkland and his comrades when he served in the Pacific during World War II and during the Korean War as a helicopter pilot. There is a love story for each of the conflicts—one between an anti-American Aussie girl and an American fighter pilot and the other between a heartbroken fighter pilot and a Japanese geisha. But the strength of the book is in its action stories. Kirkland gives excellent accounts of dogfighting Japanese Zeros and spending his days in Korea pioneering the use of helicopters for rescue, even over water. He also describes his life at a Mobile Army Surgical Hospital, or MASH unit, which he says bears a striking resemblance to television's long-running 4077th. Two of the most interesting vignettes take place between the wars when Kirkland flew from island to island in the Pacific in his helicopter, carrying a team of nuclear scientists; there he witnessed the detonation of two nuclear bombs. Another account tells of Kirkland's part in an unsuccessful search in stormy weather over Canada for a downed B-29 Superfortress that remained missing for years. Some thought the crew had defected, nuclear weapon in tow.

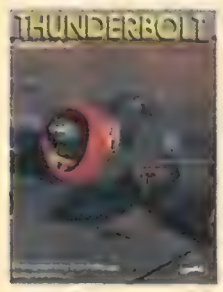
In picking up *Tales of a War Pilot*, expect "There I was" war stories, but not much beyond simple yarns.

*— Z. Byron Wolf is a journalism student at the University of California at Berkeley and a former intern at* Air & Space.

## THE JUG

### Thunderbolt: Republic P-47

*photographs by Dan Patterson, text by Paul Perkins. Howell Press, 1999. 64 pp., $15.95, color and b&w photos, (paperback).*




Includes a text and photo history of the burly Thunderbolt, as well as Patterson's lavish photographs of a restored and flyable P-47, including a sequence in which a pilot and ground crew dressed in period uniforms arm and preflight the aircraft and the pilot takes off in search of the Luftwaffe (more than 50 years too late). Other titles by Patterson in this series include *Bf 109* and *Spitfire*.

## CREDITS

**The Undertakers.** Gary L. Harris was a commercial diver for 20 years. He is now a staff member of the Air Force Missile and Space Museum at Cape Canaveral. He wrote "The Year the Rockets Came" in the Apr./May 1999 issue.

**The Last Laugh.** William Kershner was inducted into the Flight Instructor Hall of Fame in 1998. Currently, he teaches aerobatics and defensive flying in a Cessna 152 Aerobat. His last piece for the magazine was "Swordplay" (Flights & Fancy, Apr./May 1999).

**Fifteen Feet and Closing.** In the 1970s, Debbie Gary flew a Citabria, a Decathlon, and a Pitts on the two-plane Holland formation team. She flew a Pitts as the slot position on the Carling Aerobatic Team, and flew left wing on the BD-5 Jet Team. Her last article for *Air & Space* was "The Legends Club" (Oct./Nov. 1999).

Further information: *Formation Flying, the Art* (video), $74.95, from Darton International, phone (800) 713-2786; e-mail: Dartoncust.svc@thegrid.net.

**MarsAir.** London-based Oliver Morton writes about science and technology for such magazines as *Discover, Wired,* and the *Economist.* He is currently working on a book about Mars.

**The Late Show.** J. Kelly Beatty, who had an asteroid named for him in honor of his 1983 marriage, is senior editor of *Sky & Telescope,* a magazine he has worked at since 1974. He keeps an eight-inch Newtonian reflector and assorted binoculars handy for when he gets the urge to go out and see what's up.

**The NeXt Generation.** George C. Larson is the editor of *Air & Space.*

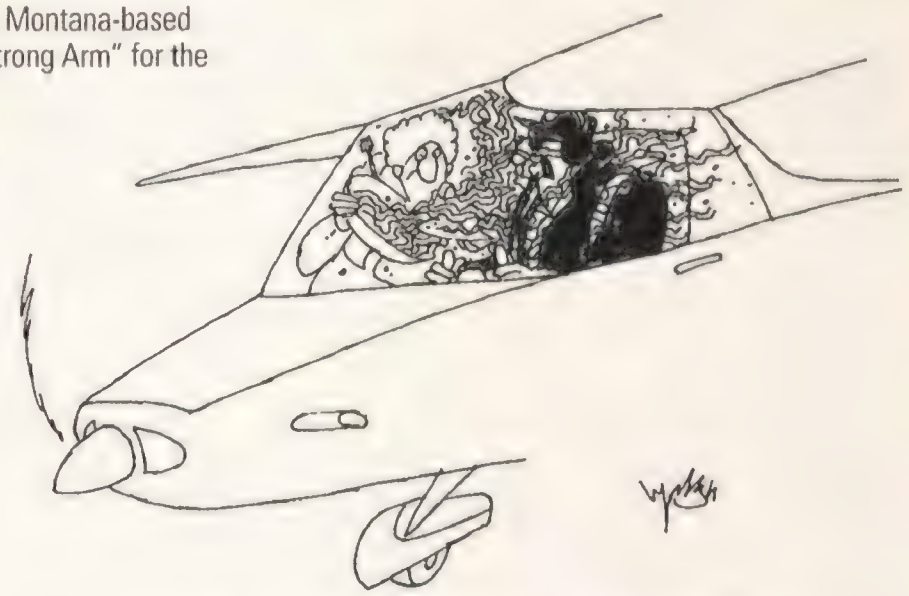
**Gear Heads.** Tom Harpole is a Montana-based freelance writer. He wrote "Strong Arm" for the June/July 1999 issue.

**NASA's Art Rides the Rails.** Freelance writer Constance Bond is a contributing editor for *Smithsonian.*

**The Coldest Warriors.** William E. Burrows is the author of *Deep Black* and several articles on reconnaissance. His most recent book is *This New Ocean: The Story of the First Space Age* (Random House, 1998).

**A Flight Along America's Highway.** John Fleischman is features editor at *Yankee* magazine. He is hard at work on a non-fiction children's book about brain science for Houghton-Mifflin.

**The Riches of East Fortune.** John Sotham is an associate editor at *Air & Space.*



*"Forget the linguini—there's too much turbulence."*

## CALENDAR

### December 1 & 2
7th Annual Air Transport Conference: The Future of Air Transport. Sponsored by the Institute of Economic Affairs. Le Méridien Hotel, Piccadilly, London, England, phone 44 (0)171 608 3491.

### December 3–5
Planetfest '99: Mission to Mars. Organized by the Planetary Society. On a 25-foot-wide screen, witness the landing of the Mars Polar Lander via a live link-up with the Jet Propulsion Laboratory. Participants include shuttle astronauts Sally Ride, Shannon Lucid, and Story Musgrave and science fiction writers Ray Bradbury and Larry Niven. Pasadena Convention Center, Pasadena, CA; phone 1-877-PLANETS, http://planetary.org.

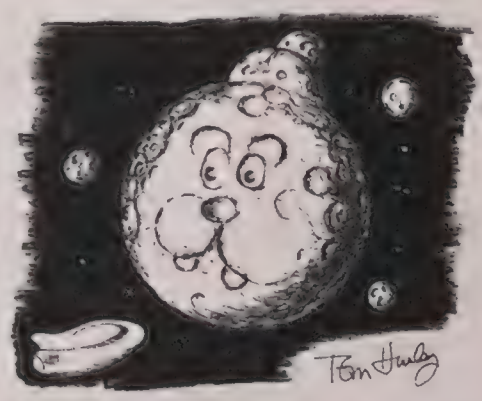
### December 4
First Saturday Pancake Breakfast Fly-In. EAA Chapter 690. Sport Aviation Center, Briscoe Field, Lawrenceville, GA, (770) 339-0804.

### December 7 & 8
American Institute of Aeronautics and Astronautics Annual Delta Forum. Washington, DC, (703) 264-7500, http://www.aiaa.org.

### December 11
"Remembrance of War" Seminar. The last great German offensive of World War II will be discussed. American Airpower Heritage Museum, Confederate Air Force Headquarters, Midland, TX, (915) 563-1000.

### January 9
Volunteer Open House. Prairie Aviation Museum, Central Illinois Regional Airport, Bloomington, IL, (309) 663-7632.

*Organizations wishing to have events published in Calendar should submit them four months in advance to Calendar,* Air & Space/Smithsonian, *901 D St. SW, 10th Floor, Washington DC 20024; fax (202) 287-3163. Events will be listed as space allows.*



*Undaunted by the failure of the first manned voyage to Pluto, mission planners simply diverted the craft to Goofy instead.*

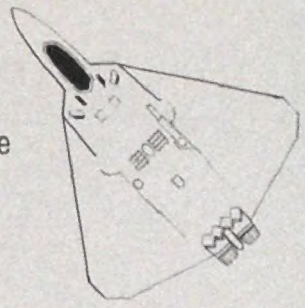
Statement of ownership, management, and circulation (required by 39 U.S.C. 3685) of AIR & SPACE/ Smithsonian, published bimonthly at the Smithsonian Institution, 900 Jefferson Drive, Washington, DC 20560 for October 4, 1999. General business offices of the publisher are located at 900 Jefferson Drive, Washington, DC 20560. Name and address of publisher: Ronald C. Walker, 900 Jefferson Drive, Washington, DC 20560. Name and address of editor: George C. Larson, 370 L'Enfant Promenade, SW, 10th Floor, Washington, DC 20024. Known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities: None. The purpose, function, and nonprofit status of this organization and the exempt status for Federal income tax purposes have not changed during preceding 12 months (Section 411.3 DMM). The average number of copies of each issue during the preceding 12 months are: (A) Total number of copies printed: 305,959; (B) Paid circulation: (1) Sales through dealers and carriers, street vendors, and counter sales: 29,858; (2) Mail subscriptions: 221,828; (C) Total paid circulation: 251,686; (D) Free distribution by mail: 2,436; (E) Free distribution outside the mail (carriers or other means): 3,609; (F) Total free distribution: 6,045; (G) Total distribution: 257,730; (H) Copies not distributed: (1) Office use, left-over, unaccounted for, spoiled after printing: 3,613; (2) Return from news agents: 44,616; (I) Total: 305,959. Percent paid and/or requested circulation: 97.7%. The actual number of copies of single issue published nearest to filing date are: (A) Total number of copies printed: 298,881; (B) Paid circulation: (1) Sales through dealers and carriers, street vendors, and counter sales: 30,669; (2) Mail subscriptions: 218,553; (C) Total paid circulation: 249,222; (D) Free distribution by mail: 2,282; (E) Free distribution outside the mail (carriers or other means): 4,759: (F) Total free distribution: 7,041; (G) Total distribution: 256,263; (H) Copies not distributed: (1) Office use, left-over, unaccounted for, spoiled: 2,512; (2) Return from news agents: 40,106; (I) Total: 298,881. Percent paid and/or requested circulation: 97.3%. I certify that the statements made by me are correct and complete.

Shelia Brannum
Business Manager



## ON THE WEB SITE

### The Generation After NeXt



NASA DRYDEN FLIGHT RESEARCH CENTER

The X-44 MANTA (for Multi-Axis No-Tail Aircraft) may be the next X-plane to fly, if studies at NASA's Dryden Flight Research Center show the concept to be feasible. The X-44 will be designed with no movable control surfaces in order to explore the use of propulsion as the sole means of controlling an aircraft. Building on the Highly Integrated Digital Electronic Control F-15 tested at Dryden in 1993, the X-44 will be equipped with a thrust vectoring system driven by engine hydraulics. Visit airspacemag.com for a link to the X-44's Web site as well as links to sites for the other X-planes.

### "Artistry of Space" Exhibit

While you're waiting for the Artrain to bring NASA's art exhibition to a small town near you, you can see some of the paintings by visiting the *Air & Space/ Smithsonian* Web site.

### Dealing With Ejection

From the most complete collections of airmen's survival gear in the country, we selected a few items to display on the Web site. Go to airspacemag.com to see examples of rare equipment and collectors' accounts of how they acquired it.

## FORECAST

### In the Wings...

#### First Up

In March 2000 an American and two Russians will become the first crew members on the international space station. We investigate what they will encounter and what they bring to the job.

#### Alone and Unarmed

The rarefied world of the reconnaissance pilot.

#### Northrop's Nemesis

Two pilots died in crashes of the F-20 Tigershark during demonstration tours in the mid-1980s. Perhaps as a result, Northrop was unable to interest foreign customers, and the program itself died. Was it a bad airplane or just bad luck?

#### Bonus Guide: Airplanes for Hire

You can hitch a ride on a Lockheed Constellation, a 1929 D-25 biplane, a T-6 Texan, 1950s Cessna seaplanes, and Stearmans galore. We'll tell you where to find them, how much it will cost, and what to wear!


JOHN HEINLY

# The Riches of East Fortune

The grasses wave in the breeze among the partially abandoned buildings at East Fortune Airfield, nestled in the hills outside Edinburgh, Scotland. A walk, map in hand, among the rounded hangars, munitions storage bunkers, machine shops, and the solitary, block-like control tower takes you through decade after decade of early aviation history. During World War I, East Fortune served as a base for British airships patrolling the North Sea for German U-boats. It was also the site from which the Scottish-built airship R34 took off in 1919 on the first round-trip flight across the Atlantic. A generation later, pilots training to search the seas for warships boarded Bristol Beaufighters on these runways. After World War II, the British converted many military airfields to industrial parks, but East Fortune was preserved, and during the cold war it was used as a food stockpile for recovery after a nuclear war.

Today, some of the buildings house artifacts of the National Museums of Scotland's Museum of Flight, though curator Adam Smith sees the old buildings as artifacts themselves. "Almost every single building is still intact," he says. "It's fascinating to get an old map of the field and find the old World War I sites."

East Fortune is one of only two airfields in Great Britain awarded the designation "ancient monument"—surprising in a country dotted with medieval castles. Most of the field, which is now owned by two farmers, is protected from commercial developers by legislation. But, notes Smith, "when you're neighboring a large city, nothing's safe."

As he strolls across the field, Smith would be easy to mistake for a college sophomore heading back to his dorm. But his youth belies a sophisticated understanding of museum stewardship and the vision he has for East Fortune. In addition to protecting the airfield from commercial development, Smith is determined to ensure the museum stirs passions for all things winged, especially among those who aren't aviation fans—yet. East Fortune hosts yearly Festivals of Flight that feature a massive fly-in, demonstrations, and lectures, and beyond that, the museum fosters a broad examination of the subject. "The name is the 'Museum of Flight'—the subject in its entirety," Smith says. "We certainly don't limit ourselves to the Scottish perspective. The upshot is the effect that aviation has had on human society."

Smith, who didn't have a background in aviation before becoming the curator, believes many aerospace museums cater too much to hardcore airplane buffs. "I feel there is an obsession with the Second World War and with military aviation in general that is sort of unhealthy," he says. "We want to pitch ourselves to the 99 percent of the population that doesn't know the difference between a Mustang and a Spitfire."

*Museum of Flight (part of the National Museums of Scotland), East Fortune Airfield, East Lothian EH39 5LF, Scotland. Phone: 01620 880308; fax: 01620 880355; Web site: www.nms.ac/flight. Open every day, 10:30 a.m.–5:00 p.m. (closing time in July and Aug.: 6:00 p.m.); closed Dec. 25 and 31 and Jan. 1. Admission: Adults, £3; kids, free.*

Which is not to say that aficionados of military aviation will be disappointed in the museum's collection. There's a Messerschmitt Me 163—a rocket-powered aircraft designed to intercept Allied bombers during World War II, and a Vietnam-era U.S. Marine Corps F-4J Phantom. In East Fortune's workshop, Derek Macphail and James Neil are restoring a Spitfire Mk 21. This example spent many years on display at a Royal Air Force base, where it was subjected to rough handling and countless rain and snow storms.

Resting on wooden jigs, the Spitfire is surrounded by several other aircraft waiting to be rebuilt or simply cleaned up for display, as well as engines and engine parts from the museum's collection, including a Daimler-Benz inverted V-12 from the Bf 110 that Rudolph Hess, Hitler's deputy, flew to England while seeking refuge during World War II. Visitors familiar with the National Air and Space Museum's Paul E. Garber Preservation, Restoration and Storage Facility, in which dusty aircraft and aircraft parts from various eras are anachronistically crowded together, will feel at home.

In keeping with the museum's mission, the restoration of the Spitfire is extending beyond the nuts and bolts. "A part of this [effort] is also an oral history project," Smith says. "We want to find the people who built it and maintained it."

This is typical of the museum's philosophy of keeping the focus on the larger story of aviation's development. The museum displays the oldest aircraft in Great Britain, the 1896 Hawk glider designed by Percy Filcher, alongside modern jet fighters; "Within 60 years [of the Hawk] we can show people an airplane that can fly at two times the speed of sound," Smith says.

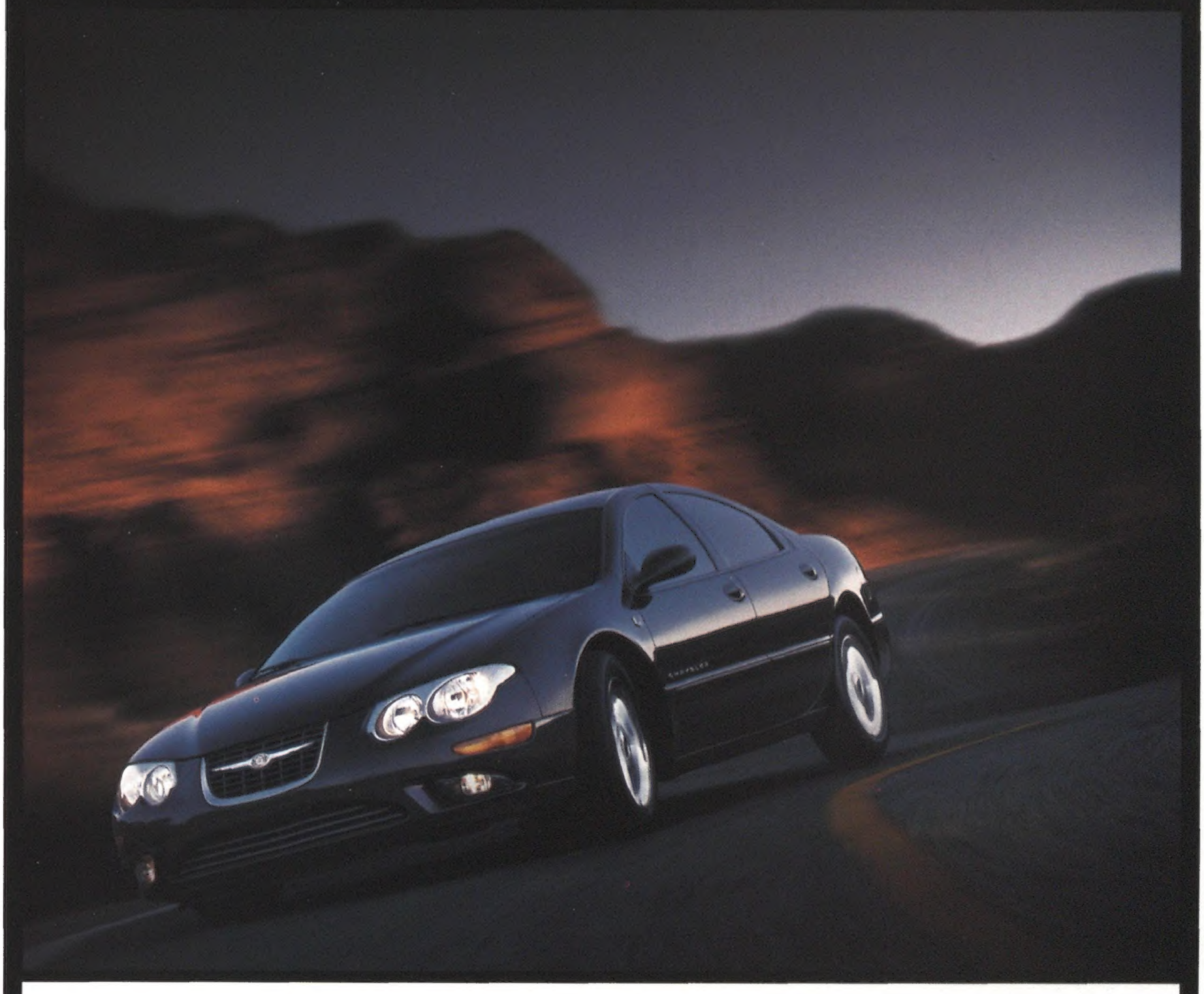
Another representative of a notable aviation milestone is the nose section of an English Electric Canberra that made the first round-trip transatlantic flight within 24 hours. The Canberra's return trip took 10 hours, three minutes; by contrast, when the R34 airship made its historic transatlantic round trip 33 years earlier, the two journeys took 108 and 75 hours.

East Fortune houses space hardware too, including a section of Blue Streak, the first stage of the Europa rocket, which was designed to launch nuclear weapons but was ultimately developed to boost satellites (a job it never got to do).

Outside, a de Havilland Comet, which is often open for tours, and an Avro Vulcan rest on a long-abandoned taxiway. The two aircraft serve as lonely sentinels, guarding the old hangars until next year's Festival of Flight and fly-in bring the drone of engines back to East Fortune.

*—John Sotham*

# Even cold rolled steel can have a heart and soul.



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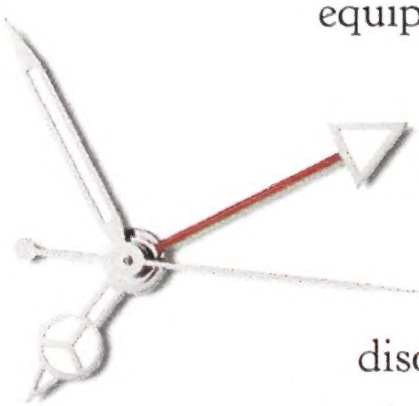

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